VOLUME 46 NUMBER 5, PART I NOVEMBER, 1958

AMERICAN JOURNAL OF OPHTHALMOLOGY

THIRD SERIES FOUNDED BY EDWARD JACKSON

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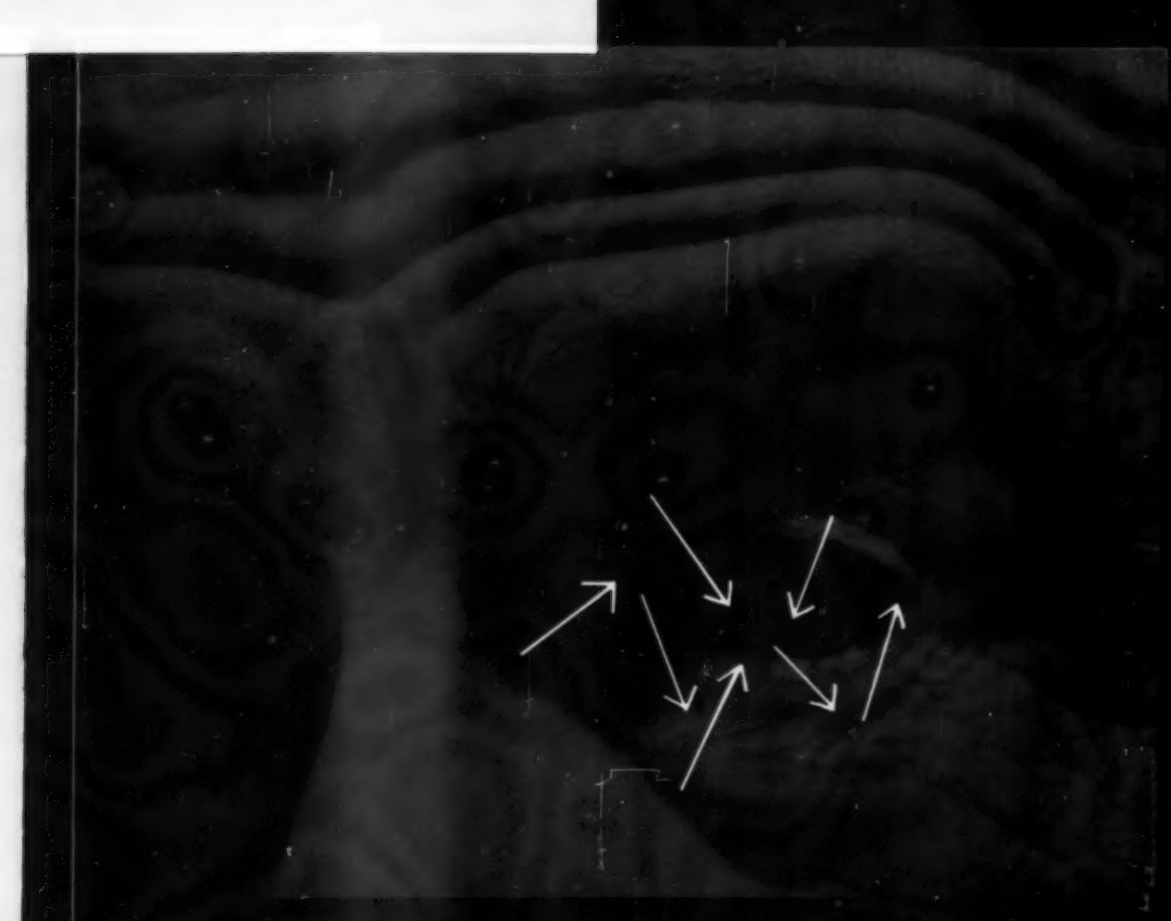

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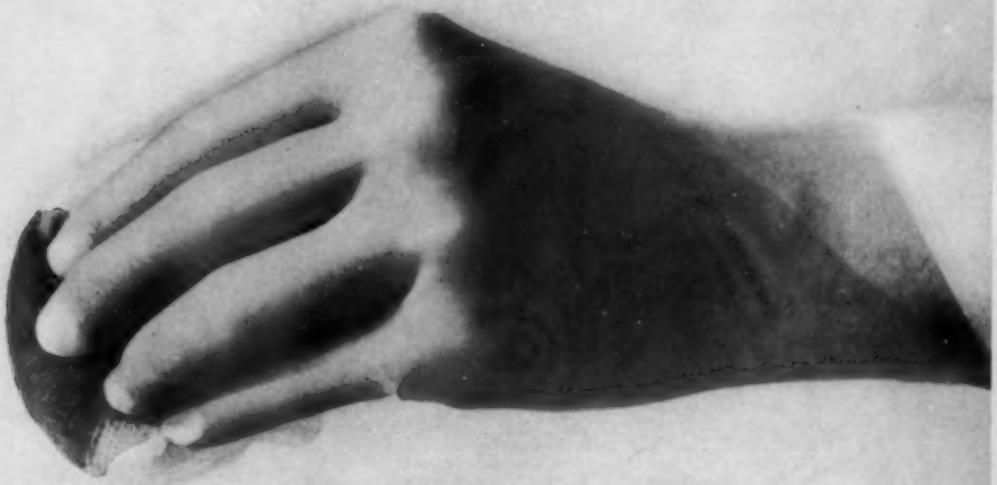

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*Council on Pharmacy and Chemistry: New and Nonofficial Remedies, Philadelphia, J. B. Lippincott Co., 1956, p. 505.

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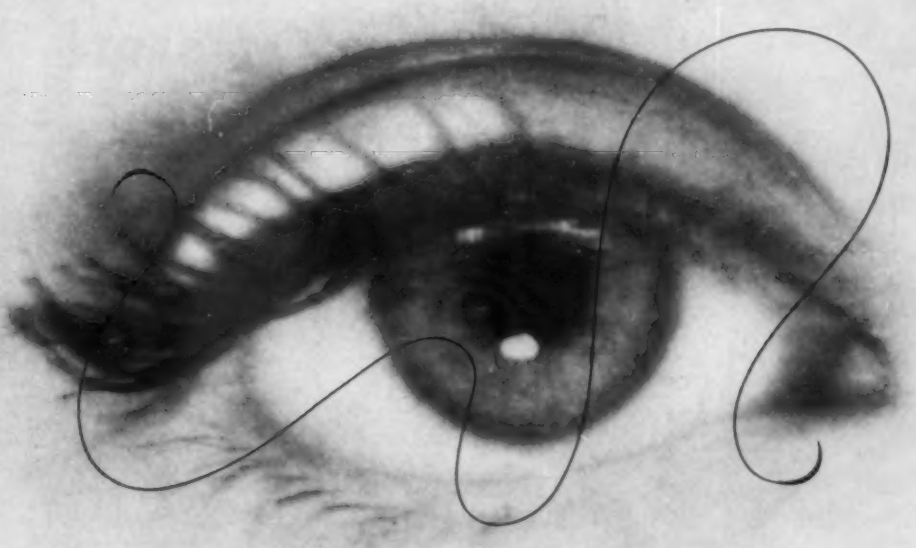

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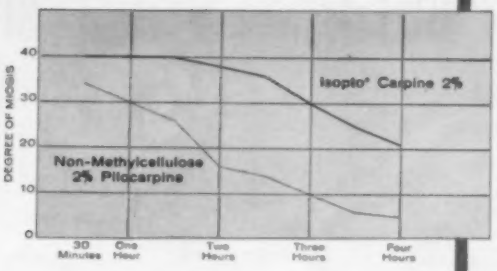

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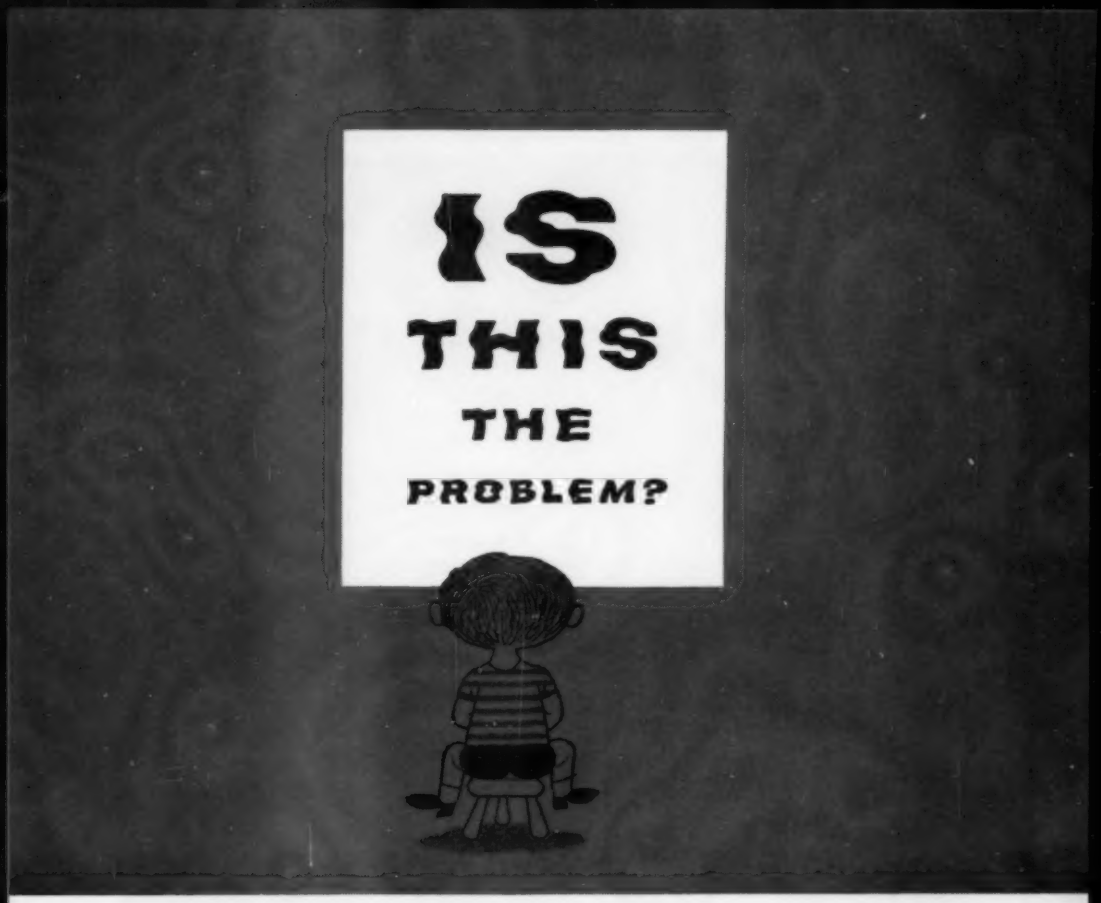

Irregular astigmatism, keratoconus, or aberrations of the corneal surface are conditions which will not allow patients to see things as they really are. The variations in curvature of the front surface of the cornea will refract light to different distances and in different directions. The spectacle lens will do very little to correct the irregular refraction of light by the cornea. Something is necessary to regularize the curvatures of the cornea. Proper fitting of a contact lens will take care of these conditions which are otherwise uncorrectable by any other means.

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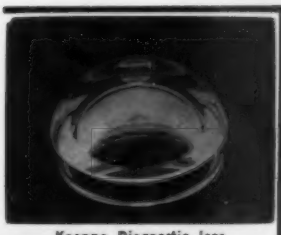

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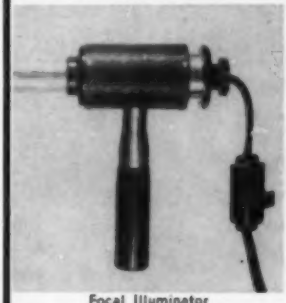

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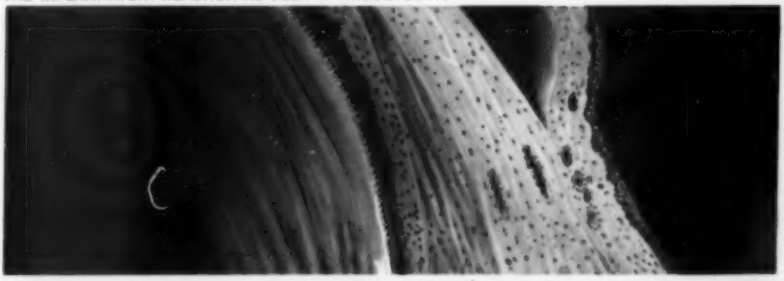
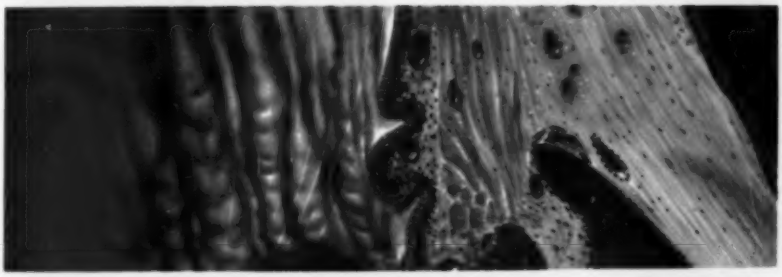
EXUDATIVE INFLAMMATION OF THE UVEAL TRACT

THE INFLAMMATORY REACTION AS SEEN IN IRIDOCYCLITIS

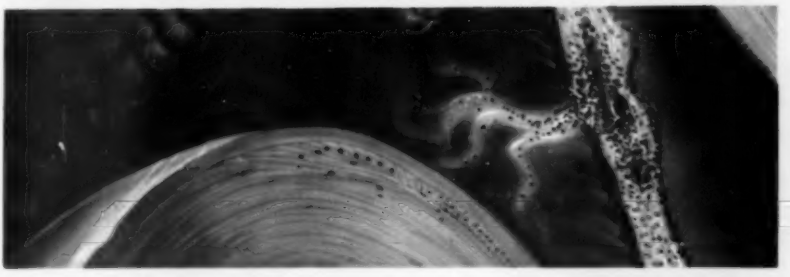
A. Normal tissue. From left to right: posterior surface of ciliary ring, ciliary retina, pigmented layer, ciliary muscle, sclera, and conjunctiva.



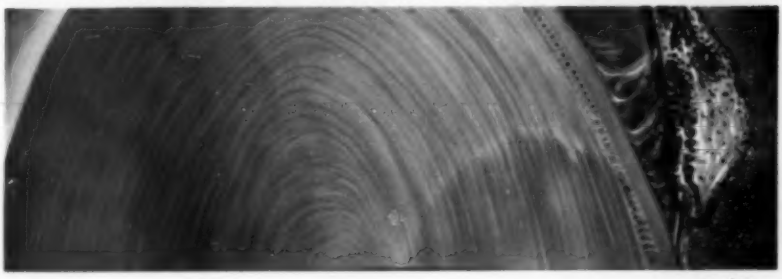
B. Hyperemia is the result of reaction to an endogenous toxin or allergen. Blood vessels are dilated. There is heightened local heat and color. Escape of blood plasma causes edema.



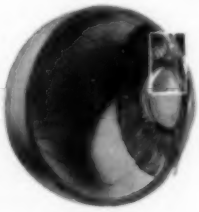
C. The next stage is that of exudation, shown here as macrophages and fibrin streaming from the posterior surface of the iris.



D. As the condition becomes subacute, there is concomitant active exudation and repair. With chronicity, fibroblasts proliferate, new capillaries develop, and various kinds of white cells appear. Formation of a posterior synechia is shown.



SCHWENK

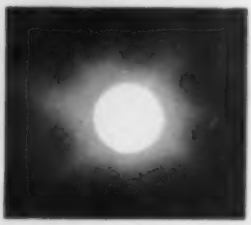


IN OCULAR INFLAMMATORY DISEASES Medrol

A SYNOPSIS OF OCULAR INFLAMMATORY DISEASE (IRIDOCYCLITIS)

Subjective symptoms:

Photophobia



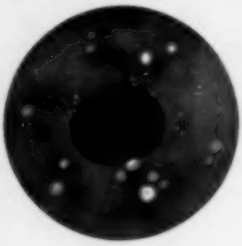
Trigeminal pain

Blurred vision

Lacrimation

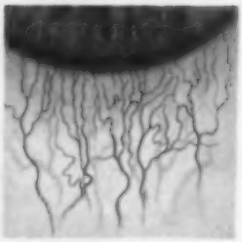
Clinical findings:

Hazy iris



Swollen upper lid

Ciliary injection



Sequelae: (if untreated)

Anterior and posterior synechiae

Lenticular changes

Secondary glaucoma

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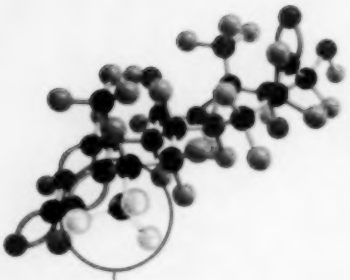

1. Feinberg, S. F.: Medrol in Allergic Conditions: Clinical and Experimental Findings, Metabolism 7:477 (July) 1958.
2. Gordon, D. M.: Methylprednisolone in Ophthalmology, Metabolism 7:569 (July) 1958.

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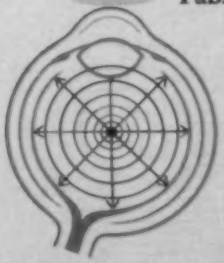

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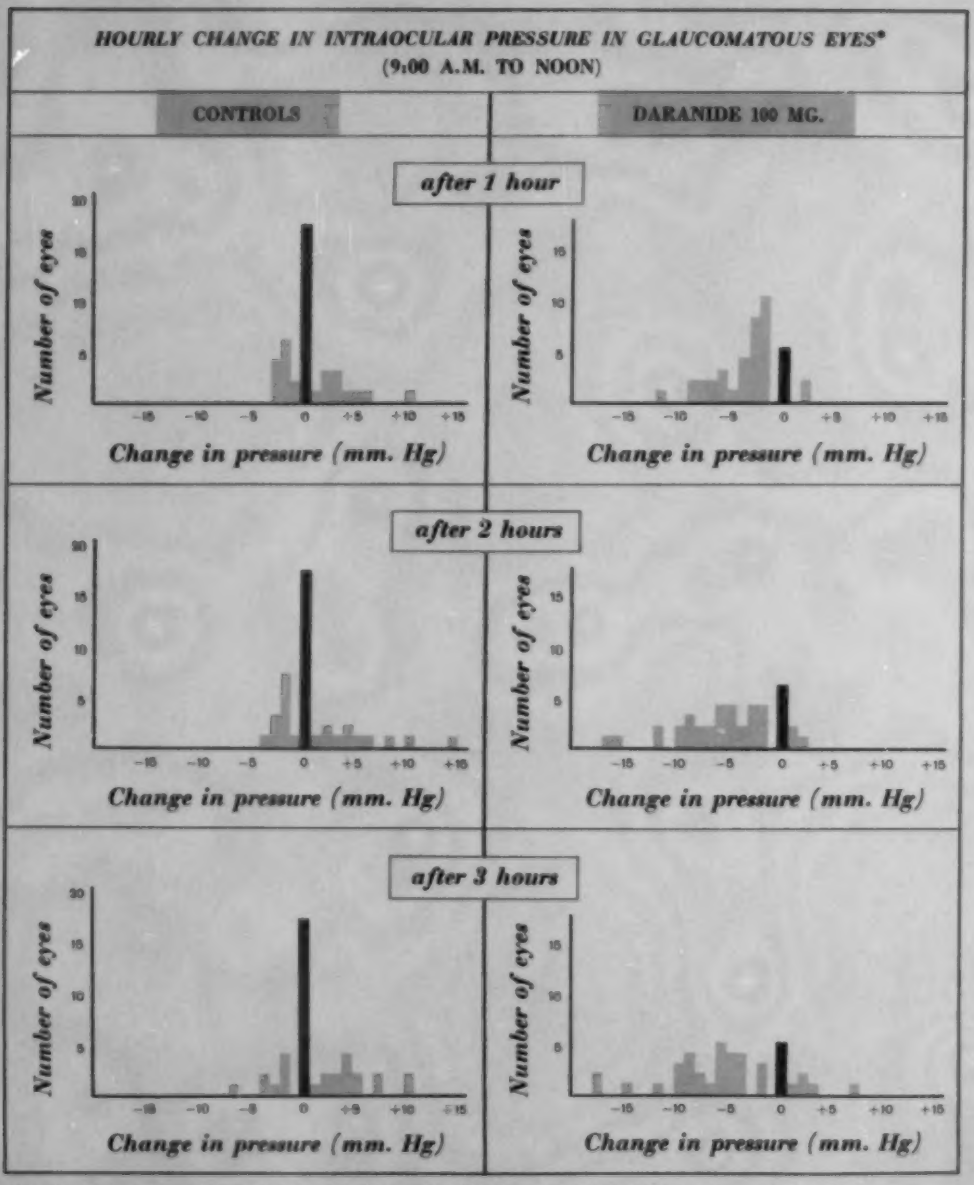

*González-Jiménez, E., and Leopold, I. H.: The Effect of Dichlorphenamide (A Carbonic Anhydrase Inhibitor) on the Intraocular Pressure of Humans, A.M.A. Arch. Ophth. 60:427, Sept. 1958.

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† $\frac{\text{Aqueous flow after treatment} - \text{Aqueous flow before treatment}}{\text{Aqueous flow before treatment}} \times 100$

**Gonzales-Jiminez, E., and Leopold, I. H.: The Effect of Dichlorphenamide (A Carbonic Anhydrase Inhibitor) on the Intraocular Pressure of Humans, A.M.A. Arch. Ophth. 60:427, Sept. 1958.*

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AMERICAN JOURNAL OF OPHTHALMOLOGY

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ABSTRACTS

General pathology, bacteriology, immunology; Vegetative physiology, biochemistry, pharmacology, toxicology; Physiologic optics, refraction, color vision; Diagnosis and therapy; Ocular motility; Conjunctiva, cornea, sclera; Uvea, sympathetic disease, aqueous; Glaucoma and ocular tension; Crystalline lens; Retina and vitreous; Optic nerve and chiasm; Neuro-ophthalmology; Eyeball, orbit, sinuses; Eyelids, lacrimal apparatus; Tumors; Injuries; Systemic disease and parasites; Congenital deformities, heredity; Hygiene, sociology, education, and history 764

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AMERICAN JOURNAL OF OPHTHALMOLOGY

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THE CORRECTION THROUGH PLASTIC SURGERY*

OF DEFECTS RESULTING FROM OPHTHALMIC MALIGNANCIES

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This presentation is primarily concerned with the correction of defects related to, or resulting from, the surgical therapy for an ophthalmologic malignancy. The treatment of the malignancy itself, as the basic subject, is not the primary purpose of this paper. This is essentially a presentation on plastic surgery, though limited to a rather definitely selected group of cases.

In many instances the defect resulting from the surgical removal of an operable malignancy can be corrected through plastic surgery at the time of the primary operation. A rather large number of cases, however, cannot be treated in this manner. Adequate reasons for postponing the corrective surgery exist either through wisdom or necessity. A small but definite number of cases need more than one operation for the final correction; that is, several different procedures are needed.

Some other factors relative to the basic subject should be emphasized, at this point, because of significant relationship. I am definitely averse to irradiation therapy as the common therapeutic procedure in ocular malignancies, even granted that many types of ocular lesions are radiation sensitive.

The ophthalmologist must remember that deaths occur with an ophthalmic malignancy from the metastases and these deaths are directly due to the method of handling the primary lesion; hence the responsibility for the treatment of these cases is a serious one. Reconstruction procedures needing flaps or a combination of mucous membrane and epithelium must be done as secondary procedures.

The tissue from all resections of lid malignancies is to be carefully studied by the pathologist, to be certain that the block of tissue removed shows normal tissue at the edges and the lower or deep surface, thus being certain that all malignancy has been removed.

There are three subdivisions of the subject, remembering the basic purposes related to the surgical correction—the adequate removal of the malignancy as a life-saving procedure and the conservation of a functioning eyeball if this is at all possible. The three subdivisions referred to are:

1. The repair of lid margin defects involving only the skin, that is, the external surface.

2. Major lid reconstructions in the presence of an intact, functioning eyeball (here is also to be included the consideration of a lacrimal sac malignancy).

3. Those lid and orbital defects related to an exenterated orbit.

Figures 1 and 2 are valuable techniques for the reconstruction of lid-margin defects related to the upper lid. The two techniques, as given to us by Fox, make possible the repair of angled defects or the larger crescentric ones.

Figure 3 is the basis for the repair of similar situations in the lower lid. It is a procedure given to us by Kuhnt. Many minor problems can be corrected in the lower lid by

* From the Graduate School of Medicine, The Graduate Hospital, The University of Pennsylvania. Presented before The Pan-Pacific Surgical Society, November 6, 1957, Honolulu, T.H.

Fig. 1 (Spaeth). (After Fox.) Tarsal replacement by transplant from the lower lid to the upper lid for lid margin defects, other than those at the canthal angles. The skin surface itself is closed by skin approximation after undermining.

a simple triangular block resection and subsequent closure in layers with (varied) lines of sutures.

Figures 4 and 5 illustrate well the repair of malignancies, away from the lid margin but involving only the skin of the lid, through the use of a free skin graft. Figure 4 is a case of Stallard's, of London, England. Figure 5 is one of my cases.

Figure 6 is a rather interesting recurrence of malignancy following a primary skin

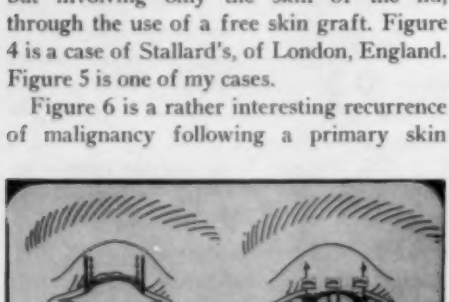

Fig. 2 (Spaeth). (After Fox.) A technique which splits the lid into its two major layers—skin and orbicularis and tarsus and conjunctiva. The differences in mobility of these two layers permits the great value this procedure has in the correction of the larger crescentic lid margin faults. An intermarginal tarsorrhaphy is a necessary part of the technique.

Fig. 3 (Spaeth). Kuhnt's techniques for replacement of lid margin defects of the lower lid as a hammock flap. The two lower illustrations have added thereto a mucous membrane graft for the correction of a conjunctival cul-de-sac defect (Axenfeld).

graft wherein the recurrence came through the central portion of the graft. It is certain that the primary resection in this case did

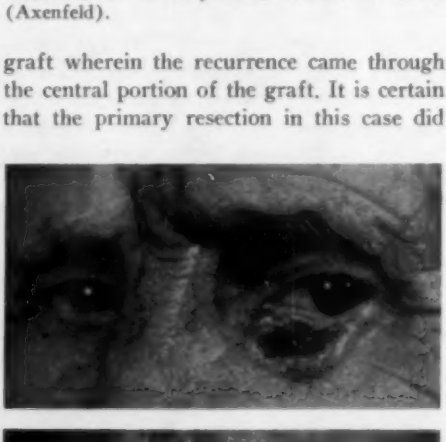

Fig. 4 (Spaeth). (After Stallard.) Free-skin graft of resected area, in the correction of a basal-cell carcinoma of the lower lid. Full-thickness skin graft.

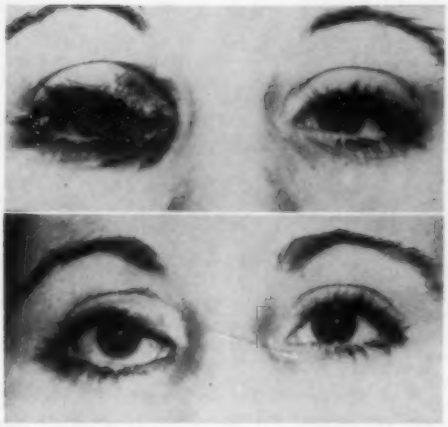

Fig. 5 (Spaeth). Full-thickness grafts, the upper and lower lids, inner canthal angle for the correction of nonmalignant melanoma (nevus?), the right eye. Correctness of the diagnosis microscopically confirmed.

not remove all the deep-lying basal-cell carcinoma originally present.

Figures 7 to 10 demonstrate beautifully

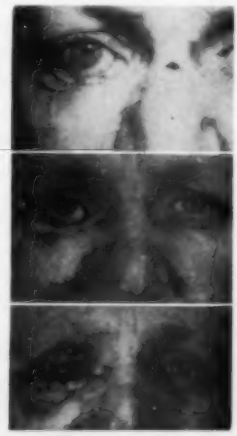

Fig. 6 (Spaeth). Carcinoma appearing in a dermatosis resulting from earlier quartz-light therapy for lupus erythematosis. (Upper) The primary correction. (Middle) A recurrence through the substance of the skin graft. (Below) The lid margin, near the external canthal angle. The lower illustration shows the case after the resection and free-skin full-thickness grafting. The discoloration of the bulbar conjunctiva is from a simple subconjunctival hemorrhage present at the first postoperative dressing.

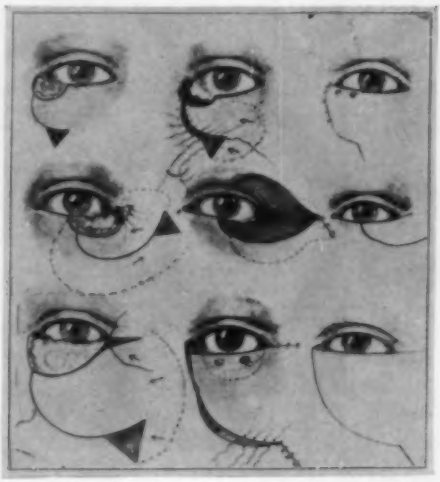

Fig. 7 (Spaeth). Imre's "Lidplastik" technique of resection-resuture of swinging flaps, and of Burow's triangles for the correction of lid malignancies.

the Imre principle for the correction of a malignancy site through the use of a sliding flap and the resection of the classical Burow's triangle. The basic principles are: (a) to resect the malignancy; (b) to undermine a flap sufficiently large to cover the resected defect; and (c) by the use of a triangle resection the contiguous lips of the wound for subsequent suture are made of the same length, approximately, so that adequate closure can be done, with sutures, from one fixed lip of the wound to the other lip, the side of the swinging flap.

Surgery for the reconstruction of major

Fig. 8 (Spaeth). Basal-cell malignancy which is well corrected by the Imre technique.

Fig. 9 (Spaeth). Composite illustration of the Imre method in a case involving the lid margin and the posterior surface of the lid.

lid defects, the upper or the lower, in the presence of an intact, functioning eyeball makes necessary at various times the use of varied surgical techniques. These involve the use of skin grafts, of pedicle flaps, of ear cartilage, the utilization of mucous membrane, and, not infrequently, the need for using a portion or all, of the lower lid for the reconstruction of the upper lid.

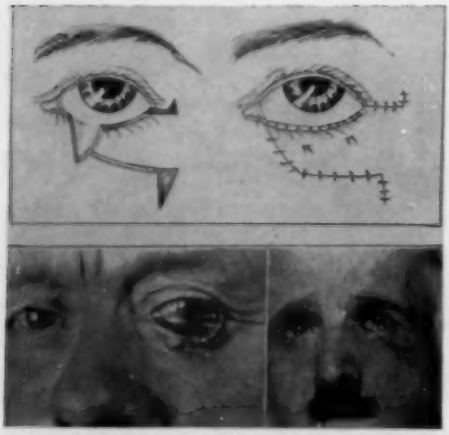

Fig. 10 (Spaeth). Similar illustration to Figure 9 of a case with the posterior surface of the lid margin involved in the malignant condition.

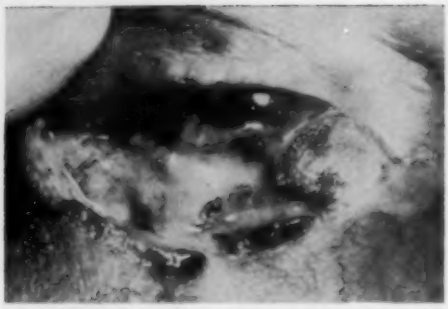

Fig. 11 (Spaeth). Lower lid squamous-cell malignancy for correction.

The technique for a lower lid repair is quite different in principle from that necessary for an upper lid repair. One cannot utilize the upper lid to rebuild the lower; this would simply transfer the defect from the lower lid into the upper lid and thereby result in a greater functional disturbance. The lower lid, however, can be used in the correction of major upper lid defects, with a functional end-result which is quite satisfactory in both the upper and lower lids. In addition, if an intact eyeball is present one must combine mucous membrane for the posterior surface of reconstructed lids with epithelium for the anterior surface. This is quite the opposite when considering the reconstruction of an exenterated socket. Here, epithelium may be used for both anterior and posterior surfaces.

Fig. 12 (Spaeth). The same patient as in Figure 11 awaiting further lid reconstruction (which he later refused being satisfied with the result) following the surgical removal of the malignant disease.

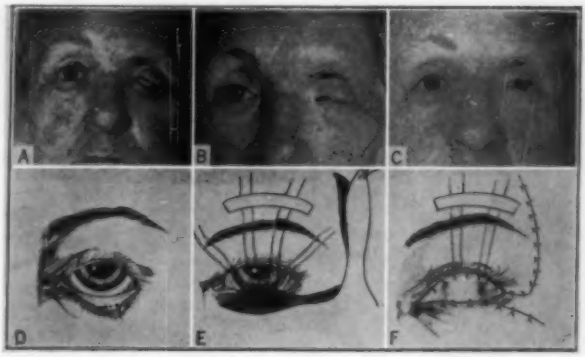

Fig. 13 (Spaeth). Composite illustration of the secondary repair of a surgical defect following the earlier performed surgery for the removal of a basal-cell carcinoma. (A-D) The defect prior to the corrective surgery. (B) The condition with intermarginal sutures still in position. (C) The end-result. (E and F) show the surgery, a pedicle flap covered upon the posterior surface with the remaining conjunctiva of the inferior cul-de-sac.

Figures 11, 12, and 13 are of lower lid malignancies. The result in Figure 12 is following recovery from the primary procedure, now ready for the secondary reconstruction. Figure 13 is the illustration of a similar case corrected with a pedicle flap as the secondary procedure. If there should be insufficient conjunctiva present, as in Figure 12, the first stage of the secondary procedure would need to be a graft of mucous membrane lining the posterior surface of the subsequent pedicle flap. This will be discussed very shortly but later herein.

Figures 14 to 17 illustrate beautifully the Landolt principle of utilizing the lower lid for the reconstruction of the upper lid. In the first of these cases the reconstructive surgery done was carried out as a secondary procedure, also in the last to be shown. In the second of these cases it was a primary procedure.

Figures 18 to 20 illustrate the simultaneous use of mucous membrane and epithelium with free skin grafts and pedicle flaps for the reconstruction of major lid defects. As can be seen, the mucous membrane is first transplanted to the site for the subsequent pedicle flap. This, in turn, is then used for the correction of the defect. These procedures are usually carried out as secondary or subsequent operations. They cannot be done in one stage.

Figures 21 to 25 illustrate similar problems related to lacrimal sac malignancies. This subject has been recently covered in its entirety* by me. The essentials in treatment of this type of malignant disease, and the repair of the surgical defect are: adequate resection of the malignancy, including exposure for inspection and necessary surgery of the lacrimal-nasal duct; primary grafting, with skin, of the operative wound; and, subsequent repair of the defect with a combina-

* Spaeth, E. B.; Carcinomas in the region of the lacrimal sac. Arch. Ophth., **57**:689-693 (May) 1957.

Fig. 14 (Spaeth). Case to illustrate the Landolt technique. (A) The remnants of the upper lid following an earlier resection. (B) During surgery before the new palpebral fissure has been made. (C) End-result, showing the extent of lid closure possible.

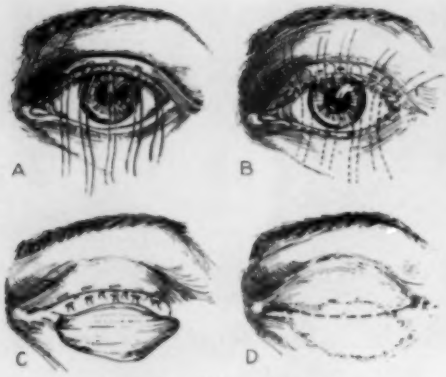

Fig. 15 (Spaeth). Schematic drawings of the Landolt technique. (A) Sutures in the posterior layer of the upper lid remnants. (B) Lower lid margin resected, sutures indicated for the closure of the posterior layer of the upper and lower lids. (C) Skin surfaces closed, skin graft position indicated. (D) Position indicated for the new palpebral fissure. Length of time necessary for the completed surgery is from two to three months.

Fig. 17 (Spaeth). Similar case, a secondary postirradiation defect, before correction, during the correction, and the end-result.

tion of mucous membrane and epithelium by means of a pedicle flap. The recurrence, if this occurs, must be followed by a complete exenteration of the orbit, including the medial wall of the orbit. The reconstructive surgery possible is controlled by the extent of surgery needed for the cure of the primary malignancy. The mortality rate of these cases, under the best of circumstances, is close to 50 percent, hence the necessity for exacting surgery.

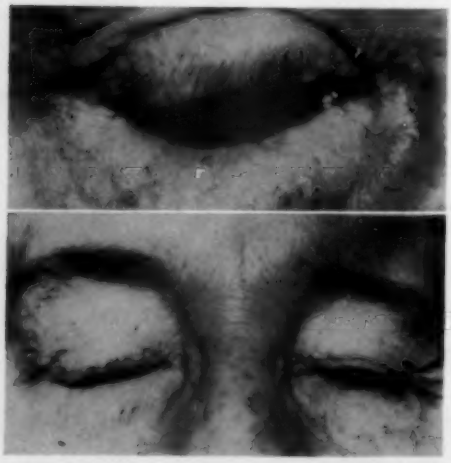

Fig. 16 (Spaeth). Case corrected as a primary procedure with the Landolt technique. Upper illustration shows the tissues newly added to the upper lid—all that lying below the accentuated palpebral fold, the site of levator attachment of transplanted lower lid; also shows well the hair-bearing graft for new eyelashes. Lower illustration shows extent of closure possible. (Patient refused additional surgery for the correction of the relative postoperative ptosis; there was no visual impairment.)

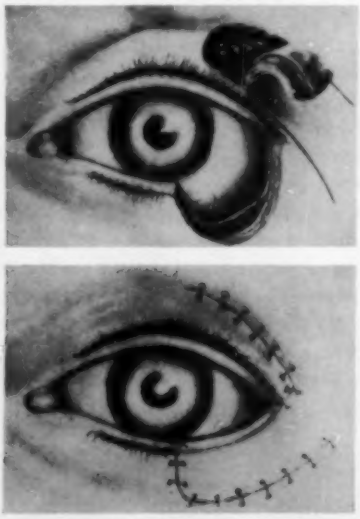

Fig. 18 (Spaeth). This illustrates schematically the transplantation, by means of a pedicle flap, of mucous membrane and skin into a surgical defect in the lower lid because of malignancy resection. The insertion of the mucous membrane graft is first carried out. The second operation is the resection of the malignancy and, at this same time, the transplantation of tissues for the reconstruction of the resected lid. (Original source of this illustration is unknown.)

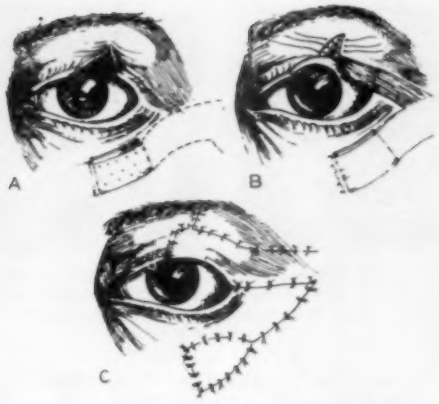

Fig. 19 (Spaeth). Schematic sketches of the technique used for the correction in the case shown in Figure 20. (A) The upper lid secondary defect after earlier malignancy resection. The mucous membrane graft is in place. (B) Pedicle flap ready for transplantation; dissection prepared for the reception of flap and mucous membrane. (C) Drawing of the tissues in correcting position.

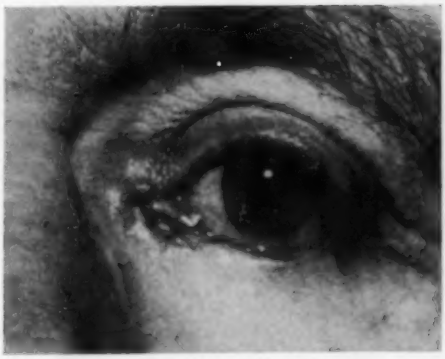

Fig. 21 (Spaeth). Malignancy of the inner canthal angle. However, the lesion was primary in the lacrimal sac.

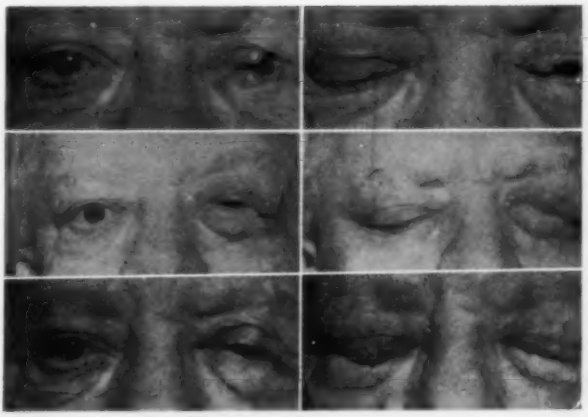

Fig. 20 (Spaeth). Upper illustrations show the defect with lids opened and closed, the middle pictures are those during the period of correction, the lowest two show the end-result with the lids opened and closed.

Fig. 22 (Spaeth). (After Shipman.) Malignancy of the lacrimal sac, at the time of patient's first admission. Condition two years later following a period of apparent recovery. The recurrence can be seen at the upper inner edge of the forehead and site of sac and duct resection. This patient died of further extension of the malignancy one year after the surgery for this recurrence.

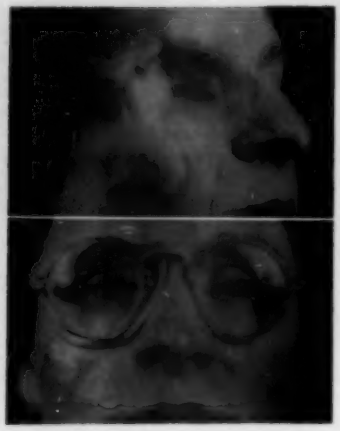

Fig. 23 (Spaeth). Five-year recovery following primary surgery which included the complete removal of lacrimal sac, lacrimal-nasal duct, and an orbital exenteration. The lower illustration shows the plastic prosthesis in the process of fitting and completion.

The third subdivision has to do with the exenterated socket. In considering the rehabilitation of a patient with an exenteration one must remember that certain cases are probably handled better by the use of a prosthesis rather than through plastic surgery. The anatomic conditions present at the time the decision is to be made control the physician's decision, though the diagnosis of the lesion which made necessary the primary orbital evisceration is also a significant factor. I have seen hemangiopericytoma appear, with subsequent death of the patient, through the epithelium as a recurrence in a grafted eviscerated socket. To the other extreme, a complete socket reconstruction will be shown shortly, a case in which the primary and secondary surgery was made necessary because of recurrent squamous-cell carcinoma, with recovery.

Fig. 24 (Spaeth). Interval period following primary resection of sac and duct with primary skin graft in position.

Fig. 25 (Spaeth). Period of secondary surgery following mucous membrane graft (foreskin) and pedicle flap. The canthal angles have since been repaired.

The two cases shown in Figure 26 are cases in which an exenteration should be the operation of choice. In both instances the pathologic condition had extended into the orbit and, considering the basic reason for the surgery—to save a life—surgery of any lesser extent than this would have been unsuccessful.

Figures 27 through 32 illustrate exentera-

Fig. 26 (Spaeth). Two cases of neglected malignancy, now of a degree that orbital evisceration is a necessary procedure.

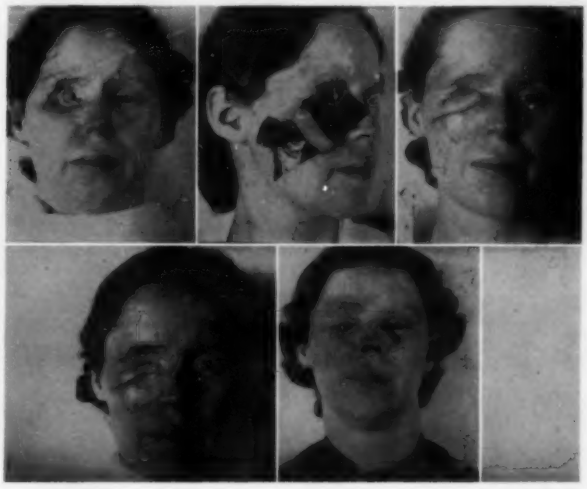

Fig. 27 (Spaeth). Defect following the surgery necessary for a recurrent squamous-cell carcinoma. The composite figure shows the formation of the epithelium-lined pedicle flap, its delayed transfer in stages, and the final result, with the new palpebral fissure and with the prosthesis in place.

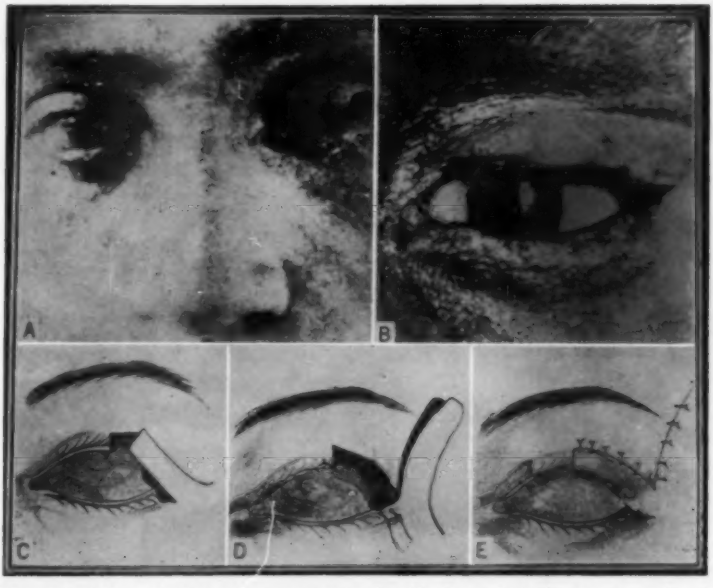

Fig. 28 (Spaeth). Reconstruction of an exenterated orbit for retrobulbar sarcoma in which the reconstructive surgery was complicated by partial loss of the reconstructed upper lid. Pedicle flaps were used (after the epithelial graft socket surgery). (E) The final result, with a prosthesis in position.

Fig. 29 (Spaeth). A similar situation, as in Figure 28, an exenterated orbit for primary malignancy, showing the patient before the corrective surgery and the final result (left).

Fig. 30 (Spaeth). The details of the surgery necessary in Figure 29. The remains of the upper lid were incised and dropped as a hinged pedicle flap to form the posterior surface of a new upper lid which, in turn, was covered with a split skin graft. The patient has, for all practical purposes, an overcorrection.

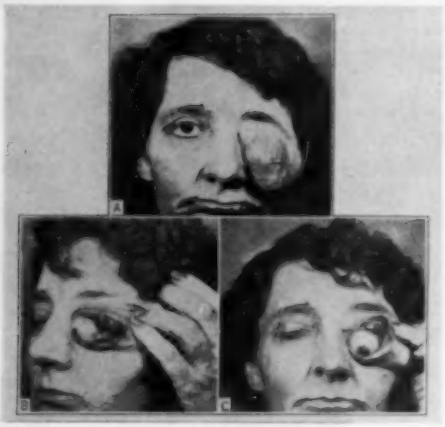

Fig. 31 (Spaeth). An illustration showing the extent of a case of neglected neurofibromatosis of the skin and orbit.

Fig. 32 (Spaeth). The end-result of the surgery of case in Figure 31. Careful inspection of the photographs will show many other skin lesions in this case of generalized neurofibromatosis. The disease was present in three generations, this patient representing the middle generation.

tion reconstructions. Figure 27 is one of the reconstruction of both upper and lower lids wherein the pedicle flap used was first lined with epithelium and then subsequently this flap was transferred to its correcting position through a series of four subtotal transfers —each subsequent operation attaching an additional portion of the pedicle flap, the last procedure being the formation of the new palpebral fissure. One must agree that, in this instance, the surgical result is superior to that possible through a correcting pros-

Fig. 33 (Spaeth). Giant-cell sarcoma involving the orbit and secondarily the ethmoidal sinus. The sequence of primary site and secondary extension is not clear.

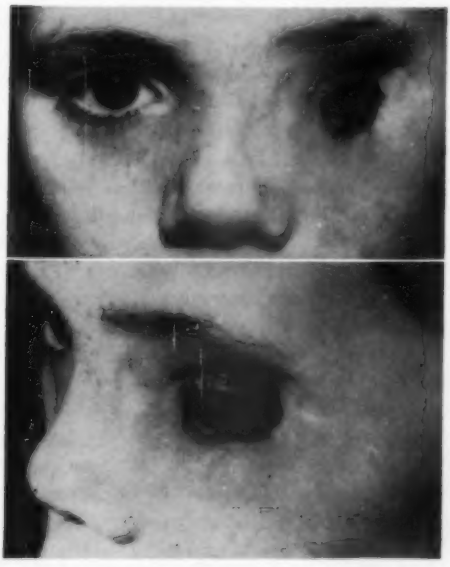

Fig. 34 (Spaeth). Recurrence (see Figure 33) one year after primary surgery.

Fig. 35 (Spaeth). Two years later (See Figures 33 and 34). The final result is shown with the patient wearing her corrective prosthesis.

thesis as in Figure 23.

Figures 28 to 30 are illustrations of the repair of partial exenteration defects through pedicle flaps and/or skin grafts. Figures 31 and 32 illustrate the repair of neurofibromatosis through radical surgery. In this the lid remains were sutured together in the midline as a permanent diaphragm knowing that further reconstruction surgery should not be done. The bony socket was almost completely destroyed because of the neurofibromatosis. The lids were closed over the exposed dura.

Figures 33 to 35 illustrate an example of giant-cell sarcoma; the primary lesion (the only photograph I have of this); the site of recurrence; and, the final recovery with the patient wearing a prosthesis.

Conclusion

In conclusion one comment must be made. It is quite likely that timid primary surgery by the ophthalmologist is the greatest single fault in the treatment of ocular malignancies. A second fault which, unfortunately, is beyond our control, is inadequate primary, as well as subsequent, treatment which is so frequently administered by some dermatologists and roentgenologists. The problem is not new, nor is it being corrected with the passage of time. This is one reason why I feel so strongly that ocular malignancies are primarily a surgical problem and the responsibility for their proper treatment belongs to the ophthalmologist alone.

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SURGICAL MANAGEMENT OF EXOTROPIA*

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For the purposes of this presentation, exotropia will be considered as a *constant* relative divergence of the visual axes for any given fixation distance. This is by way of contrast to exophoria and intermittent exotropia. It is the element of constancy which differentiates the problem under discussion from the latter two instances.

Patients with constant exotropia exhibit the most profound sensory- motor anomalies. Constant exotropia is the last stage of a progressive disease process. It is of interest to note that one does not see infants with constant exotropia, except in bizarre instances.

Visual infants (under six years of age) may exhibit a constant exotropia only in later years, and as a rule do not develop the constancy until after the age of six years.

The surgical management of constant exotropia, therefore, is primarily concerned with visual adults, who possess less adaptability of the sensory mechanisms.

Since all constant exotropes have passed through the earlier stages of exophoria and intermittent exotropia, it is paradoxical that they all have experienced good binocular fusion, while at the same time have developed a most profound sensory suppression and secondary motor defects.

It will be the purpose of this paper to point out the sensory and motor defects associated with constant monocular and constant alternating exotropia, and, by example, to show the surgical steps directed at affecting both the sensory and motor aspects of the problem.

What are the sensory-motor defects in constant exotropia? Hemiretinal regional suppression is large in extent and deep. Monocular amblyopes characteristically have a "built-in" suppression. That is, it is usual to be able to account for an over-all blur of the retinal image in one eye by a significant amount of anisometropia, a corneal scar, lens opacity, or some similar such phenomenon. With such "ready-made" suppression it is not necessary for the sensory mechanism to make such a marked adaptation to a new motor position, and hence most monocular exotropes have an amblyopia of arrest with normal retinal correspondence. Monocular and alternating exotropes may, at the outset of the disease process, differ only slightly in the degree of blur of the retinal image in one eye as compared with the fellow eye.

When the differential blur is significant, the route of a monocular exotrope may be taken rather than an alternating equal visioned exotrope. In constant alternating exotropia, the visual acuity is characteristically equal in the two eyes, the hemiretinal suppression becomes a sensory adaptation, and anomalous retinal correspondence is usually present. It is in this type of strabismus that the deviation becomes of very large magnitude and all the sensory-motor anomalies most profound indeed.

The anatomic (motor) factors in the management of exotropia are also of extreme importance. Anyone who has operated upon patients with constant alternating exotropia of large degree cannot help but be impressed by the purely mechanical difficulties in effecting straight eyes by surgery upon the extraocular musculature and the surrounding structures. Most of these, however, are secondary anatomic effects consequent to the widely divergent position of the eyes over a period of time. In the management of divergent ocular deviation *both* the sensory and anatomic factors require special attention. While it is probably true that the anatomic

* From the Department of Surgery (Ophthalmology), Stanford University School of Medicine. Presented at the VII Congress of the Pan-Pacific Surgical Association, Honolulu, November 14-22, 1957.

machinery is primarily at fault during infancy, it is the sensory suppression mechanism that proves to be the more important problem in the management during later infancy and early visual adulthood. Once the constant alternating, or monocular, divergent stage is reached, the secondary anatomic factors indeed become a large problem in management. Now both the sensory and anatomic factors are considerable, and form the basis for the widespread dissatisfaction with the present methods of treating this latter type of case.

In the management of exotropia, the presence of a good fusion potential is the surgeon's best assistant, and the lack of this potential, in the form of sensory suppression, is his worst antagonist. This factor is so germane to the proper evaluation of surgical management of exotropia that one cannot afford to omit it in assessing the mechanical effects of surgical techniques.

Although it is desirable when possible to incorporate pre- and postoperative antisuppression orthoptics as an adjunct to surgery, the surgery alone may do this via overcorrection of the exotropia. Unwittingly or unknowingly, ophthalmic surgeons use surgical instruments as orthoptic instruments by jolting the fusion mechanism through surgery. Surgical overcorrection of exotropia invariably results in diplopia which may be sufficient to awaken an always dormant normal correspondence fusion and result in greater percentage of cures. Surgical treatment may influence not only the anatomic factors, but, through surgical overcorrection of the defect, may also materially influence the sensory mechanism.

Vertical noncomitancy is a common occurrence in both monocular and alternating exotropia. This is usually due to secondary involvement of the oblique muscles in the divergent eye. A divergent position of an eye favors shortening of both obliques with consequent overaction and contractures. The more constant the deviation, and the greater the magnitude of deviation, the more marked the overactions of the obliques. It is not uncommon to find an overaction of both agonist and antagonist obliques in the same eye. In alternating exotropia, the oblique overactions, if present, may not be equal in both eyes with a consequent hypertropia. Symmetric bilateral overaction of both superior oblique muscles is best detected by examination of the direct up versus the direct down fields of gaze. The difference in *horizontal* components of the deviation may differ by as much as 80 prism diopters in these two positions of gaze.

Surgery of monocular exotropia

The treatment is usually for cosmetic purposes since the exotropic eye is usually amblyopic. It is not unusual, however, to find a functional as well as a good cosmetic result with stable peripheral fusion. One recalls that such patients have a good normal retinal correspondence fusion potential. Monocular surgery is indicated, and is usually re-emphasized by the fact that the patient will not allow surgical attack upon the good eye. Full recession (seven to eight mm.) of the lateral rectus is indicated, combined with substantial resection of the medial rectus (the degree of resection depends upon the magnitude of deviation). Proper isolation of the medial rectus with severing of the intermuscular membranes and check ligaments allows large resection of this muscle to be done without untoward effects upon the palpebral fissure and caruncle position. When, after severance of the horizontal recti, there is still difficulty in mobilizing the globe and rotating it nasally, one may enhance the mobility of the globe by weakening the proper oblique muscles. An anatomic contracture of one or both obliques may prevent adequate nasal rotation of the globe. When one oblique markedly overacts relative to the other, it alone may be tenotomized. When both obliques overact markedly in the monocular amblyopic exotrope, then both obliques may be tenotomized fully. It must be emphasized that tenotomy of a superior oblique muscle is an

irreparable procedure and should not be done in a seeing eye without very proper and strict indications. However, in an amblyopic eye which is not visually rehabilitable, tenotomy of one or both obliques is possible to enhance mobility of the markedly divergent eye. The forced duction test at the time of surgery as well as ocular rotations preoperatively will dictate this procedure.

Surgery of constant alternating exotropia

These adult patients usually have an exotropia of very large magnitude and of very long standing. It is not surprising, therefore, that the most profound sensory anomalies are found as well as marked secondary anatomic effects. The early literature describes placing a stay suture from the eye to the brow or nose in order to "hold" the eye in position.

Symmetric, bilateral, and preferably simultaneous bilateral, surgery is indicated. It is well known that simultaneous surgery on both agonist and antagonist enhances the mechanical effect from what might be expected by the same surgical procedure on either muscle when done as a sole procedure or at different times. Similarly, simultaneous bilateral surgery enhances the mechanical effect of the surgical re-alignment over what might be expected when monocular surgery is done in separate stages. When the time interval is shortened between the two-stage monocular surgical procedures, the mechanical effects are enhanced. When the time interval is shortened to zero (simultaneous bilateral surgery) one succeeds in obtaining large amounts of correction, which is usually indicated in these patients. One should aim at a slight overcorrection of the entire deviation by operating upon the four horizontal recti at one surgical session. Both lateral recti are recessed fully (seven to eight mm.), one medial rectus is resected, and the other medial rectus is shortened preferably by an O'Conner cinch operation. The latter procedure is a "safety valve" and allows regulation of the postoperative effect within the first 48 hours postoperatively by removing some of the cinch material.

In true alternating exotropia, the oblique overactions are usually (although not always) symmetric and are ameliorated symmetrically with surgical re-alignment by attack upon the four horizontal recti alone.

Such symmetric, simultaneous, bilateral surgery profoundly affects the sensory mechanism. It has been my experience that postoperative drift is negligible following such procedures, and that normal retinal correspondence and the dormant good fusion potential are allowed to manifest themselves.

The attainment of both a functional and a cosmetic result with this procedure is not unusual, and is in contrast to the results achieved by less bold procedures.

The empirically determined surgical indications with respect to *time* of operation, *type* of operation, and slight postoperative *overcorrection*, are all mechanical dictates of the sensorial mechanism, which is of especial importance in the management of constant exotropia.

Summary

Constant exotropia is characteristically a disease of visual adults. Its surgical management differs from that in exophoria and intermittent exotropia.

The sensory defects in monocular and alternating exotropia are discussed.

The motor defects are usually secondary, with frequent involvement of the oblique muscles.

The surgery of constant monocular exotropia is usually cosmetic in purpose and may be confined to monocular surgery.

The surgery of constant, alternating exotropia of large degree should be directed at a symmetric, simultaneous, bilateral surgical procedure upon the four horizontal recti muscles.

The concept of "surgical orthoptics" is discussed.

Secondary divergence (exotropia) is not included in this discussion.

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TECHNIQUE OF TREATMENT OF INTRAOCULAR TUMORS WITH RADON SEEDS*

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This paper is really a plea to induce you to consider trying a method of treating retinoblastoma which is simple and effective. There are no technical difficulties associated with it beyond the exercising of great care and patience and following out a routine plan. It constitutes a direct attack on the tumor or tumors, as multiple tumors can be treated at the one operation. All it requires is the closest team work between the ophthalmologist and the radiotherapist.

Dr. Kaye Scott and I have worked together throughout the whole of the development of this technique. Previously Dr. Kaye Scott had devised a method of attaching radon seeds to the inner perichondrium of the larynx after removal of the thyroid cartilage and from this procedure he got the idea of applying a similar scheme to tumors of the eye. We spent a lot of time on dissections and experimenting on available subjects. Trial operations with inactive seeds were done on eyes that were being enucleated and from these ventures we were able to work out the beginning of our present technique.

INTRODUCTION

Possibly owing to various technical difficulties encountered in the past with the implantation of radon seeds for the treatment of retinoblastoma, misconception still exists in the minds of many ophthalmic surgeons regarding the disadvantages of this method. Such objections as the inability to treat multiple tumors at the one time, lack of control of irradiation, and its effect on other parts of the retina have been raised.

None of these objections can be applied to the present method, mainly because an entirely different type of seed is used. They are fixed according to a plan calculated to give the tumor area an accurate homogeneous dose of irradiation without injuring the surrounding retina.

In the past it was often customary to apply single seeds of one or two up to even four or five mc. to the sclera in the vicinity of the tumor and in such cases it was impossible to obtain a homogeneous dose over the tumor area. This method often caused violent reaction and destruction of tissue. In our method 0.9 mc. is the greatest strength of any single seed and sometimes the strength is as low as 0.1 mc.

Foster Moore and particularly Stallard did most of the pioneering work and experiments in the treatment of retinoblastoma with radon seeds and plaques and for this we owe them a lasting debt. The seeds available to them were made of glass tubes coated with platinum. Their active length varied up to six mm. and their diameter was 1.4 mm. and they were one and two mc. in strength. Earlier Stallard used seeds up to the order of four mc. and over. Stallard found that seeds of this length and thickness inclined to ride at a tangent on the sclera. He gave up the use of seeds in 1948 and he now uses a radium plaque which is fixed to the sclera by means of an applicator.

In 1943, with our first patient, we wanted to find a method of fixing seeds directly on the tumor area which would overcome the previous objections to radon seeds. We found that no one had tried to adopt Paterson and Parker's scheme for obtaining dosage homogeneity with the use of radon seeds in the eye. Their method, which was designed for ordinary clinical purposes, was based on a treatment distance ("h") of 0.5 cm.

This distance is too great for use in the

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small areas found in tumors of the retina so a shorter distance of 0.3 mm. was adopted. This became practicable because Oddie (1940) published a method of dosage calculation from which the number of millicurie hours required for 1,000 r could be obtained for any area at any treatment distance.

Dr. Kaye Scott reasoned that, if we took a tumor one cm. in diameter with the base on the retina one mm. away from the implantation plane on the sclera, the tumor being raised two to three mm. above the retina and, if the arbitrary distance "h" of three mm. were chosen, we could follow the rules of Paterson and Parker relating the diameter of the treated area "D" to the treatment height "h" and apply their principles in this special site with D/h ratios generally less than six, for example, D/h = 1.0/0.3 = 3.3. See Figure 1.

In this way rules for distribution of radon could be used as in ordinary radiotherapeutic practice. Such planning for these eye cases would allow the use of a single ring or a ring plus a central spot. If D/h is less than three we can use a circle of seeds only; if it is greater than three we are required to use a circle of seeds plus a central seed. It is on this basis that our present treatment scheme is planned.

The seeds we use are made of capillary gold wire into which the radon is pumped.

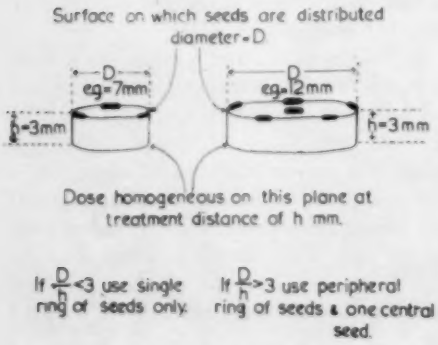

Fig. 1 (Joyce). Radon distribution diagram.

They are cut to the required length with micrometer forceps which seals the ends at the same time. They are usually about three mm. in length, 0.75 mm. in diameter and with filtration equivalent to 0.3 mm. platinum. They have a small groove in the center in which a suture can be secured. They are made to order in strengths of from 0.10 mc. to 0.90 mc. and can be obtained in steps of 0.05 mc. They are fixed firmly to the sclera with silk and are left as permanent implants. We think that 13,500 r at 0.3 cm. "h" is an optimum dose for areas of 0.7 to 1.2 cm. in diameter.

Technique

When it comes to the actual fixing of the seeds to the sclera there are two important considerations:

1. Where to fix the seeds.
2. How to fix the seeds.

Of these two considerations the first presents the more difficult and more important problem. It is imperative that the radiotherapist and the ophthalmologist act in close co-operation and it is better still if two ophthalmologists can examine the patient together and check one another's measurements.

The measuring of the tumor, fixing its position in the globe, and determining its axis is time-consuming and difficult and requires a lot of patience on the part of all concerned. In the case of babies and young children it must be done with a general anesthetic and the pupil should be well dilated under atropine. More than one examination is necessary to get a thorough picture of the tumor, its size, and position in the globe.

Although measuring the tumor by means of the ophthalmoscope using the disc as 1.5 mm. may not sound a very accurate method, in actual practice, with careful checking, it has proved to be remarkably reliable. The fact we are working with high magnification with the ophthalmoscope reduces the possibility of error.

Fixing the axis, measuring from the an-

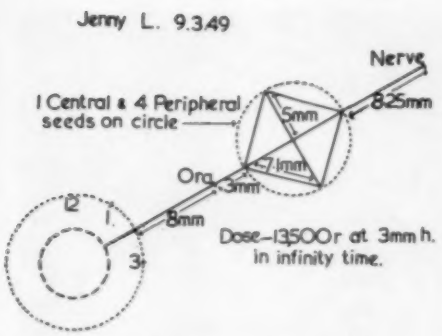

Fig. 2 (Joyce). Treatment plan.

terior margin of the tumor forward to the ora, and from the posterior margin of the tumor back to the optic nerve, help in the final result of accurately placing the tumor. Its height above the surrounding retina is also estimated.

When these measurements are agreed upon, we draw up a plan of the inside of the eye and then transfer it to a diagram of the outside of the globe. This diagram shows: (1) the axis; (2) center of the tumor; (3) anterior and posterior measurements from the limbus to the tumor margins along the axis; (4) width of the tumor (fig. 2).

From these measurements Dr. Kaye Scott and his staff draw up a few alternative plans so that the one most suitable to the case can be chosen. This plan allows for the irradiation of an area two-mm. greater in diameter all around than the tumor-bearing area.

The Commonwealth X-ray and Radium Laboratory make the seeds to order when the operation time is fixed so that the seeds will be of the required strength when implanted.

When, at the operation, a canthotomy has been done and the globe exposed, a transilluminator is placed on the opposite side of the globe to the tumor. In this way the whole outline of the tumor can sometimes be shown in shadow and marked in India ink. It can then be accurately measured directly and, if necessary, a new plan can be calculated and made to the corrected measurements by the radiotherapeutic personnel in attendance. The finished plan is drawn on a large scale and is pinned to the gown of an attendant so that it can be readily referred to.

Operative technique

A general anesthetic is required. Calipers preset to the required measurements are ready. The cornea is marked at the 12-o'clock position so that it can be identified in any position into which the eye may be rotated.

In many cases the axis in which the tumor lies can be checked at the beginning of the operation by holding a sharpened wooden swab stick vertically on the limbus and lining up the axis of the tumor with the beam of the ophthalmoscope. The axis of the tumor is marked by placing a point on each margin of the cornea either with the fine sharp point of a stick and India ink or gentian violet. The correct marking of the axis is most important because all the measurements for the correct placing of the seeds depend on the accuracy of the axis.

A silk suture on a fine needle is passed through the distal end of the axis on the side of the cornea remote from the tumor and tied. It is then passed through the point on the tumor side of the cornea. For example, if the tumor is situated in the left eye on the nasal side in the 10-o'clock to 4-o'clock meridian, the suture would be tied at the 4-o'clock point and the next bite of the suture would be at the 10-o'clock point.

A wide canthotomy is made to allow as much room as possible for the field of operation. The conjunctiva is divided parallel with the limbus over a sufficiently large area to give free exposure. If the tumor is situated far back posteriorly a second cut in the conjunctiva at right angles to the first may be made. If this is done it is advisable to mark the points where the division is made with sutures to facilitate the replacement later. Any necessary muscles may be cut and marked in a similar fashion.

When the field is fully exposed the suture across the cornea should be carefully lined up to mark the axis back along the sclera and firmly sutured to the episclera as far back as may be necessary. We have found this to be the best way of marking the axis. It simplifies what used to be the rather difficult task of measuring and keeping the line of the axis correct.

Using the plan as a guide, the first point to be marked, measuring from the limbus with sharp-pointed calipers, is the center of the tumor. This is marked on the axis line with India ink. From this point the positions of the most posterior seed or seeds are then marked.

When the key positions are marked it is not necessary to go on marking the positions of all the other seeds. It is better to fix one or two key seeds in position first and from this fixed point or points, the other points can be measured individually and the seeds fixed one at a time until the whole pattern is completed.

We have found it advisable to suture the most posterior seed first because there is then less chance of it being interfered with by subsequent maneuvers. This seed may be on the axis or there may be a seed on each side of the axis and on this account sometimes substitute plans are prepared so that at the time of operation the one that is easiest to carry out can be chosen.

These posterior seeds are the most difficult to fix and it is here that having preset calipers for cross measurements saves a lot of time and trouble. Dr. Kaye Scott usually marks the spot with two sets of calipers while I place the suture needle in the sclera.

The posterior seed is often close to the optic nerve and sometimes the tendon of the inferior oblique has to be cleaned off the sclera at its insertion to clear the field. We use a Grieshaber 82/7 needle and there is no difficulty in placing a suture and tying a seed in this position. A good bite of the sclera is taken at the point marked and one tie is made with forceps.

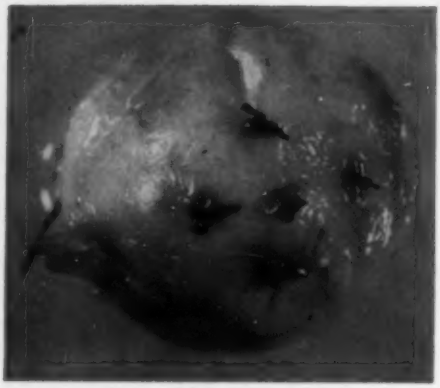

Fig. 3 (Joyce). This photograph shows inactive seeds sewn on to a specimen eye which was later mounted in a perspex jar. Course silk was used here to withstand the necessary treatment for fixing the specimen. The thread we use as a routine is Fil' a Cornée de Kalt.

The seed is introduced into the loop thus formed with special holding forceps and the seed is firmly held in position against the sclera until the loop is tightened over the central groove in the seed. The holding forceps is then removed and the second loop of the knot is securely completed with the forceps. The seed is inspected to see that it is properly in position with the silk thread in the groove.

When the first seed is implanted each of the other seeds is placed in similar fashion after checking the measurements from the axis and the center of each other seed. The vena vorticosa sometimes shows up during these procedures but, with alternative plans already prepared, there has been no difficulty in avoiding it.

Care is taken to place the seeds as far as possible with their long axis in line with the circumference of the circle of irradiation. Sometimes the seeds rotate a little on their axis but it is not of the greatest importance. The seeds are so small that the whole of the surface of the seed fits firmly against the sclera (fig. 3).

TABLE 1

DOSAGE CHART

NUMBER OF MC. REQUIRED TO GIVE 13,500 R AT 0.3 MM. H IN INFINITY TIME

Circle of Diameter of Tumor (mm.)	Area (cm.²)	Mc.hr. 1,000 r	Total mc.	Suggested Distribution Au. (0.3) Filtered Seeds	
				Peripheral (mc.)	Center Spot (mc.)
6	0.283	22	2.25	3×0.75	
7	0.385	25	2.58	3×0.85	
8	0.502	29	2.92	3×0.9	0.2
9	0.635	32	3.26	4×0.75	0.25
10	0.785	36	3.66	4×0.85	0.25
11	0.948	39	4.0	5×0.75	0.25
12	1.13	43	4.4	5×0.85	0.2
13	1.33	47	4.8	5×0.9	0.3

We allow two mm. all around for margin of error.

COMPLICATIONS

There are no complications when the tumors are not near the anterior part of the globe. When they are well forward in the eye, changes may occur in the conjunctiva, lens, cornea, and eyelids but these changes are not of much significance as a rule.

In one case, a boy who had three successive tumors in one eye, a second tumor had to be irradiated adjacent to one that had been treated 12 months earlier. These two areas overlapped so an overdose could not be avoided. An advancing keratitis developed which extended inward on the cornea, with accompanying vascularization. A progressive symblepharon also developed. In later cases we avoided the danger of symblepharon by the use of a contact lens, with the center removed, which was designed to keep the lids well away from the globe.

In this same boy some fine dustlike opacities and a few strias were observed in the outer part of the lens near the site of the tumors after five and one-half years. It is 14 years since this boy was operated on and he has 6/12 vision and was second in his class at school last year. He still has some trouble with the keratitis and symblepharon but, as the condition is still slowly progressive, we have not tried to do anything about it yet.

For the benefit of those who may not be in a position to be able to work in close association with a radiotherapist, a plan has been drawn up to show a suggested distribution of the seeds to irradiate an area for a tumor of a given diameter (table 1).

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REFERENCES

Joyce, A.: Tr. Ophth. Soc. Australia, **4**:98, 1944.
———: Tr. Ophth. Soc. Australia, **9**:1, 1949.
Joyce, A., and Scott, R. K.: Acta XVII Internat. Cong. Ophth. 1954, p. 453.
Moore, Stallard, and Milner: Brit. J. Ophth., **15**:673, 1931.
Oddie, T. H.: Brit. J. Research, **13**:155, 1940.
Reese, A. B.: Tumors of the Eye. New York, Hoeber, 1950, p. 108.
Stallard, H. B.: Brit. M. J., **2**:962, 1936.
———: Brit. J. Ophth., **22**:604, 1938.
———: Brit. J. Ophth., **32**:618, 1948.

GLIOMA OF THE OPTIC NERVE AND ITS MANAGEMENT*

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Although gliomas of the optic nerve are relatively uncommon, they occur frequently enough to consider them in every case of proptosis of the globe.

A study of these tumors in the registry of the Armed Forces Institute of Pathology reveals occurrences of 18 per 50 thousand. At Walter Reed Army Hospital, in-patient and out-patient lists show about one third of this incidence for all ages of individuals seeking ophthalmic examination and care. Observations show glioma to be a disease of puberty, the average age being from 10 to 12 years. The youngest patient was seven months old, while the oldest was 47 years. Ingalls,[1] however, reports glioma to be a disease of infancy while Katzin[2] agrees with our observation.

Discussion of the disease would be incomplete without a review of the histoanatomic structure of the optic nerve which is unlike peripheral nerve. It is similar in architecture to the cerebral pathways except for the presence of vasculofibrous septa which divide the nerve into bundles. The nerve fibers are further separated by glial network, the cells of which resemble those found in the central nervous system. These cells are the astrocyte, the oligodendrocyte, and the microglial cell.

The tumor may grow from any one of these cells. The dominant cell is usually the astrocyte. However, many specimens show an equal distribution of astrocytes and oligodendrocytes. According to Davis[3] these cells may develop tumors which may be described in five different stages. There may be a generalized hyperplasia of the astrocytes and the oligodendroglial cells in the nerve stem. The reaction has a low grade malignancy; it is neoplastic, but slow growing. Extensive growth through the pial sheath occurs. The arachnoid thickens at this point and hyperplasia at this location forms a large mass.[4] Cells may penetrate the arachnoid mass and may mingle in a cellular growth in which the cells are almost indistinguishable. Davis[3] believes this explains why so many pathologists agree the tumor arises from the arachnoid.[5] Gliomatous growth always destroys most of the landmarks of the sheath; and there is a haphazard intermixture of glial and pial cells.[6] All landmarks within the nerve as well as the sheath are completely obscured by the tumor. Accumulation of the so-called cytoid bodies occurs in these tumors. They are about the size and shape of ganglion cells. They probably represent a change in the neuroglial cells. Verhoeff believed they originated within the neuroglial syncytium from degenerating blood cells, as he noted them in degenerating areas at sites of previous hemorrhage. Cystic spaces may be seen and a deposit of calcium may be an added feature. Grossly, the tumors are firm with a slate-colored cast (fig. 5).

Although the tumor is unilateral, simultaneous occurrence in both optic nerves has been reported. Spread from one optic nerve to the other may occur by way of the chiasma. The tumor may grow posteriorly into the chiasma (fig. 4) or anteriorly toward the eye producing marked papilledema.

The clinical diagnosis is not always easy as one can believe when he reviews the cases submitted to the Armed Forces Institute of Pathology. The period of onset to recognition of the disease varied from four months to two years. In all cases, proptosis of varying degrees was observed. Figures 1 and 2 are photographs of patients with mild to marked protrusion of the eye. All the tumors

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† Since this paper was presented Col. Spaulding has been transferred from Walter Reed Army Hospital, Washington, D.C., to Fort Sam Houston.

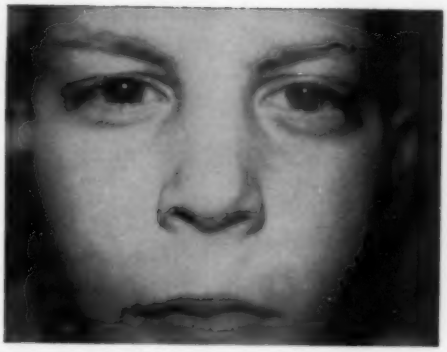


Fig. 1 (Spaulding). Ten-year-old boy, showing proptosis of the left eye of two months' duration.

Fig. 3 (Spaulding). Tumor completely extirpated. Proximal end shown on forceps in surgeon's hand. Incision was at the chiasm.

were unilateral. In the series of all cases reviewed the youngest patient was a seven-month-old white male child. Papilledema was recorded in the histories of half the cases from the Armed Forces Institute of Pathology, but was observed in all patients examined at Walter Reed. In the last two years, two patients with glioma of the optic nerve were seen at Walter Reed. One of these presented altitudinal field defects; the other, light perception only. Records of the Armed Forces Institute of Pathology revealed three cases of optic atrophy as the outstanding funduscopic finding. X-ray studies of the foramen showed only two with measurements over seven mm. Pfeiffer considered anything above six mm. as enlargement. To summarize the diagnostic points, proptosis in a young individual is presumptive. Papilledema occurs in 95 percent of all patients. Unilaterality is almost 100 percent. X rays may show enlargement of the optic foramen. Field defects are usually altitudinal. The disease is that of young people, although in one case found in the registry, a Negro, aged 47 years, had glioma of the optic nerve for two years before diagnosis was made.

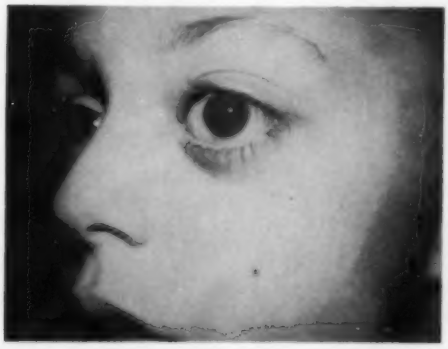


Fig. 2 (Spaulding). Ten-year-old boy, showing proptosis of the left eye of eight months' duration.

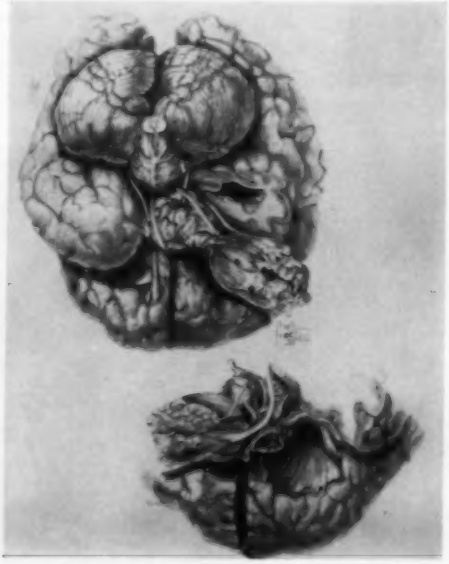


Fig. 4 (Spaulding). Gross specimen, showing glioma of the optic nerve invading the chiasm.

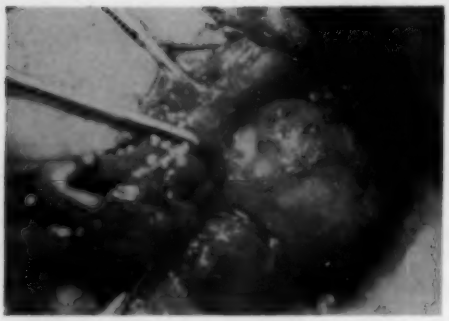


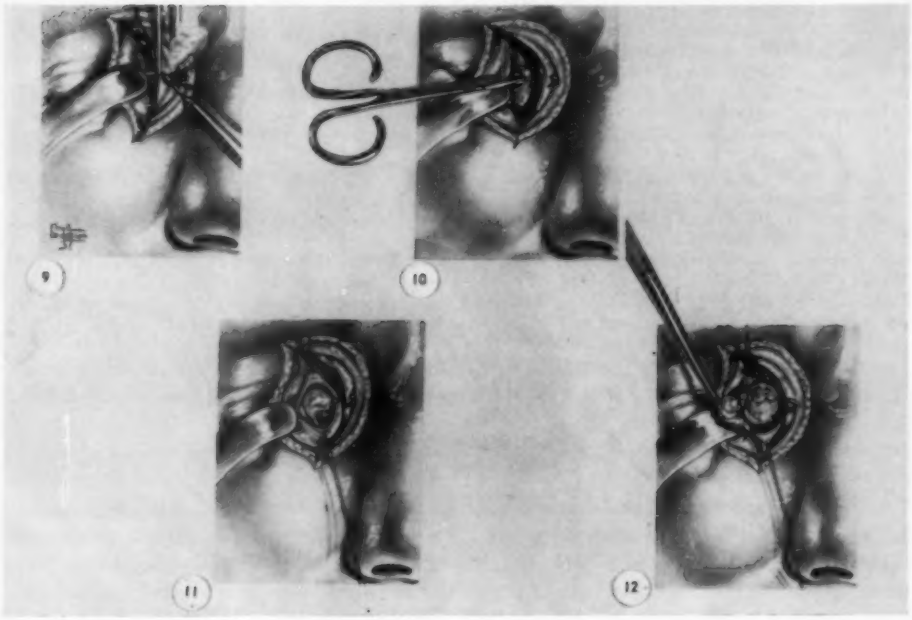
Fig. 5 (Spaulding). Gross appearance of tumor as it was brought into the neck of the wound. The lesion is slate colored.

Additional considerations in diagnosis are found in other reports. Martin and Cushing,[11] Davis,[12] and Levitt[13] have emphasized the fact that primary optic atrophy or unexplained blindness with no exophthalmos is not infrequently caused by tumor of the optic nerve. Somethimes these cases are incorrectly diagnosed as retrobulbar neuritis. Martin and Cushing,[11] Davis,[12] and Aegerter and Smith[14] have reported cases in which there was no exophthalmos. Recognition in these cases of peripheral nerve signs of even mild von Recklinghausen's disease is extremely important.

Treatment of these tumors has been varied. X-ray therapy has been advocated by some and the results have been encouraging. However, patients complain of prolonged periods of discomfort because of skin changes and radiation illness associated with treatment. Neurosurgeons[7] favor severing the optic tract near the chiasma, freeing the meningeal coverings of the nerve, and allowing the entire nerve to be removed anteriorly through the optic foramen.

A surgical technique has been developed at Walter Reed Army Hospital for removal of the tumor with less trauma and a most thorough extirpation of the tumor. In this technique the Killian type of incision is used (fig. 6). The next step is the exposure of the tissues down to the periosteum (fig. 7), which is incised along the maxillary ridge. Freer's elevator is used to raise the periosteum and the periorbita (fig. 8). The anterior ethmoidal artery is clamped and severed with a cautery (fig 9). An incision is made with scissors to open the periorbita (fig. 10). With a finger, the tumor is located. The optic nerve is gently retracted with a Smithwick cervical hook and the distal end is severed (fig. 11). The proximal nerve is carefully dissected free from the region of the annulus. In order to preserve the musculature and its function, this procedure must be

Figs. 6, 7, and 8 (Spaulding). (6) Killian incision. (7) Exposure of medial palpebral ligament, frontal and maxillary ridges. (8) Incision through the periosteum.



Figs. 9 to 12 (Spaulding). (9) Exposure of anterior ethmoidal artery and its severing with cautery. (10) Opening of periorbita with scissors. (11) Tumor brought into the wound. (12) Nerve with tumor exposed by a Smithwick hook.

handled very gently and meticulously. Photographs show the appearance of the tumor after removal (fig. 3).

Marshall in 1953[9] and Manschot in 1954[10] reported an association between optic nerve glioma and von Recklinghausen's neurofibromatosis. About 10 percent of these tumors[8] are associated as primary growths with neurofibroma of the skin and neural tissues. Although our cases did not have manifestations of neurofibromatosis, the reports of the association of these two diseases make it imperative that the clinician be aware of the possibility of the two conditions existing in the same case.

Summary and Conclusion

Study of gliomas reveals a low-grade malignancy but exceedingly great destruction by extension. Their incidence is relatively rare. It is a disease almost entirely of early age and adolescence. Diagnosis is not always easy; periods of seven months to two years have elapsed between the initial examination and the final inspection. X-ray therapy has been advocated by some as the treatment of choice; but at Walter Reed the extirpation of the tumor and the entire nerve to the chiasma has been adopted. This is followed by observation at quarterly intervals.

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References

1. Ingalls, R. G.: Tumors of the Orbit and Allied Tumors, Springfield, Ill., Thomas, 1953.
2. Katzin, H. M.: Glioma of the optic nerve. J. Mt. Sinai Hosp., Mar.-Apr., 1945.
3. Davis, A. D.: Primary tumors of the optic nerve. Arch. Ophth., **23**:735-821, 1940.
4. ———: Glioma of the optic nerve. In Reese, A. B.: Tumors of the Eye. New York, Hoeber, 1950, p. 157.

5. ———: In Reese, A. B.: Tumors of the Eye.
6. ———: Primary tumors of the optic nerve, Arch. Ophth., **23**:957-1022, 1940.
7. Hayes, G. J.: Personal communication.
8. Reese, A. B.: Tumors of the Eye. New York, Hoeber, 1950. Page 151.
9. Marshall, D.: Glioma of the optic nerve as a manifestation of von Recklinghausen's disease. Tr. Am. Ophth. Soc., **51**:117, 1953.
10. Manschot, W. A.: Primary tumors of the optic nerve in von Recklinghausen's disease. Brit. J. Ophth., **38**:285, 1954.
11. Martin, P., and Cushing, H. W.: Primary gliomas of the chiasma and optic nerves in their intracranial portion. Arch. Ophth., **52**:209-241, 1923.
12. Davis, A. D.: Primary tumors of the optic nerve (a phenomenon of von Recklinghausen's disease). Arch. Ophth., **23**:735-821; 957-1022, 1940.
13. Levitt, J. M.: Discussion in Davis, A. D.: Primary tumors of the optic nerve. Arch. Ophth., **23**: 735-821; 957-1022, 1940.
14. Aegerter, E. E., and Smith, L. W.: Case of diffuse neurofibromatosis involving cranial, peripheral, and sympathetic nerves accompanied by tumors of the hypothalmus. Am. J. Cancer, **31**:212-220, 1937.

RETINAL HEMORRHAGES IN THE NEWBORN*

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Very little has been written about retinal hemorrhages in the newborn since 1941. Although it may be of less importance than some of our major ophthalmologic problems, it seems justifiable to call attention to this condition from time to time.

Previous to 1941 there were several papers on the subject. Most writers have begun their discussion by referring to Ehrenfest's[1] monograph of 1922. All of the papers have been to some extent concerned with the cause of the condition. Eades[2] thought the duration of labor had little effect but that the use of forceps was a definite factor. Schleich[3] attributed hemorrhage in the retina of the newborn to asphyxia and venous congestion.

Jacobs[4] thought this unlikely, since there are relatively less hemorrhages in the retina following breech deliveries. Jacobs also was of the opinion that no ill-effects resulted from these hemorrhages; however, he did have one patient with amblyopia, who had more hemorrhages in the retinas at the time of birth than any other of his patients.

Sykes[5] noted a general but no definite relationship between retinal hemorrhage and signs of intracranial trauma. Rowland[6] warned that the use of pituitrin during labor might be a factor in causing retinal hemorrhage in the baby. Jacobs found retinal hemorrhages in one of three patients with hemorrhagic disease of the newborn.

Authors have found varying incidence of this condition from 10 to 46 percent of the cases. This variation seems to be due to case selection and time of examination after birth.

McKeown,[7] in a study of 498 newborn infants, found retinal hemorrhages in 42.1 percent during the first 48 hours after birth. He concluded that though there was no general agreement as to the exact cause of the hemorrhages, the main factor was believed to be congestion of the retinal veins, resulting from increased intracranial pressure brought about by the circumstances of labor.

Hemorrhages vary greatly in extent and appearance. They may occur anywhere in the fundus, though most of them are seen around the posterior pole. There may be a single flame-shaped lesion on the disc, at the disc border, or along the retinal vessels. On the other hand, the greater portion of the fundus may be covered with hemorrhages, which partly or completely cover the disc,

* From the Abington Memorial Hospital, Abington, Pennsylvania. Presented at the VII Congress of the Pan-Pacific Surgical Association, Honolulu, November 14-22, 1957.

including the macula. Grossly, there are four types of hemorrhages seen, as described by Richman.[8] The flame-shaped hemorrhages are by far the most common; next are the grossly round ones which are considered as being in the deeper layers of the retina, or possibly even in the choroid. They are bright red in color. Then there are some sharply circumscribed, perfectly round, deep-red hemorrhages. Occasionally one of these has a pinpoint white center. These occur rather infrequently and may occur anywhere, but I have seen at least a few of them in the macula. The fourth group consists of subhyaloid hemorrhages. These are seen quite infrequently.

I[9] reported the findings in 3,381 newborn less than 72 hours of age (nearly all under 48 hours) in 1941. The present presentation is a continuation of that study. The 1941 report included 2,915 ward patients and 466 from the private service of Dr. Roland Porter. This presentation includes 7,727 ward patients and 3,198 private patients of Dr. Porter.

Tables 1 and 2 are sufficient to indicate the relationship between the type of labor and the resultant retinal hemorrhages in the baby. These are taken from the 1941 report.

It is noted that in general the ward and private patients follow a similar pattern. There was no spectacular difference as the result of the duration of labor. It appears to me, however, that the very short and very long labors are more likely to result in retinal hemorrhages in the babies.

TABLE 1

RETINAL HEMORRHAGES IN RELATION TO TYPE OF DELIVERY: WARD PATIENTS

Type	No. of Cases	Hemorrhages	Percent
Normal primipara	562	115	20.4
Normal multipara	1,673	265	15.8
Low forceps primipara	363	84	23.2
Low forceps multipara	108	25	23.1
Mid & high forceps primipara	38	18	47.3
Mid & high forceps multipara	13	6	46.1
Breech	92	7	7.6
Podalic version primipara	2	2	—
Podalic version multipara	7	2	—
Cesarean section	55	4	—
Total	2,915	528	18.1

TABLE 2

RETINAL HEMORRHAGES IN RELATION TO TYPE OF DELIVERY: PRIVATE PATIENTS

Type	No. of Cases	Hemorrhages	Percent
Normal primipara	16	4	25.0
Normal multipara	78	13	16.6
Low forceps primipara	168	25	14.8
High forceps primipara	93	16	17.2
Mid & high forceps primapara	36	13	36.1
Mid & high forceps multipara	23	5	21.7
Breech	18	0	—
Podalic version	1	1	—
Cesarean section	33	0	—
	466	77	16.5

There was no relationship between the eye or eyes involved and the head presentation during labor. Toxemia of late pregnancy of the mother appeared to be a factor of some importance.

Prematurity is not a factor. Very few prematures reveal retinal hemorrhages. My observations agree with those of Sykes, that there is a general but no definite relationship between intracranial trauma and retinal hemorrhage in the newborn. The pediatricians have requested that they be alerted whenever a baby has any number of retinal hemorrhages. Hemorrhagic disease of the newborn appears to be an important factor in the cases involved. Rowland's warning concerning the use of pituitrin in the second stage of labor appears to be warranted. This drug is, however, used very sparingly and no significant number of observations is available.

In 1941 Pray, McKeown, and Pollard[10] observed that the incidence of retinal hemorrhages in the newborn was markedly reduced in infants of mothers treated with a vitamin K preparation during or prior to labor. Their results suggested that the reduction was greater when treatment was started before labor. In 1956, Nonna Pie-

trowa[11] suggested administration of vitamin K before delivery.

In this study a total of 7,727 ward patients were examined from 1931 to 1956, the number per year varying from 135 to 392, and the incidence of retinal hemorrhage in one or both eyes ranging from 14.1 to 25.2 percent with an average of 18.2 percent in different years. From 1937 to 1956, 3,198 private patients were observed, the number ranging from 94 to 244 per year and the incidence of hemorrhage in the retina varying from 8.5 to 24.0 percent in different years. For the 10,925 patients the average incidence was 17.7 percent.

A vitamin K preparation was given to all mothers when they arrived in the hospital (with few exceptions) from 1941 to 1947. During these years 2,134 ward and 1,481 private patients were seen with an incidence of retinal hemorrhage of 18.2 for the ward and 17.8 for the private patients; that is, about 18.0 percent for the entire group. There seemed to be little effect from the vitamin K as used in this manner. Perhaps it was given too late. Its use was discontinued entirely because of the increased incidence of phlebitis in the mothers.

I have always had a clinical impression that there is a relationship between the incidence of retinal hemorrhages in the newborn and the duration and severity of labor pains following rupture of the fetal membranes. This may be associated with greater pressure changes in the fetal circulation as the result of unequal pressure distribution. In addition, the counter-pressure of the fluid against the eyes and cranial fontanelles can conceivably cause pressure changes in the retinal vessels more rapidly and more markedly than when the membranes are intact. This is in accord with McKeown's observation that abnormalities of labor are an important factor.

To make careful observations on this problem would require a great deal of time and effort but it might well be productive of information of value to us, especially in connection with intracranial trauma. Follow-up studies for later signs of possible birth trauma might well be worth while. This also would require a great deal of time, effort, and money.

So far as the eyes themselves are concerned we have very little evidence that the hemorrhages result in any real harm. They absorb very rapidly. During these 26 years some of these patients have come under my care, but I have not been able to find one with amblyopia or any other defect, in whom I had seen retinal hemorrhages of any degree at time of birth.

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References

1. Ehrenfest: Birth Injuries of the Child. New York, Appleton, 1922.
2. Eades, M. F.: New England J. Med., **201**:151 (July) 1929.
3. Schleich: Quoted by Jacobs.
4. Jacobs, M. W.: J.A.M.A., **83**:1641 (Nov.) 1924; Tr. Am. Acad. Ophth., 1928.
5. Sykes, C. S.: Texas State J. Med., **26**:878 (Apr.) 1931.
6. Rowland, W. D.: Am. J. Ophth., **18**:647 (July) 1935.
7. McKeown, H. S.: Tr. of Am. Ophth. Soc., 1940.
8. Richman, F.: Tr. Internat. Ophth. Cong., **4**:76, 1937.
9. Kauffman, M. L.: Pennsylvania M. J., Sept., 1941.
10. Pray, L. G., McKeown, H. S., and Pollard, W. E.: Am. J. Obstet. & Gynec., **42**:836-845, 1941.
11. Pietrowa, N.: Klinil:a Oczna, **26**:67, 1956.

SOME OPHTHALMOLOGIC PROBLEMS IN NEW ZEALAND*

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I take this opportunity of thanking you for inviting me to read a paper at this, your seventh congress. As a New Zealander (New Zealand being situated at the most southerly angle of the great Polynesian triangle, while your series of lovely islands which make up Hawaii and of which Honolulu, the capital, is the place of our meeting today, are situated at the most northern angle) and as a member of the Polynesian Society of New Zealand, I would be less than human if I did not experience a great emotional thrill in speaking in the very city where a New Zealand doctor and a very much greater Polynesian labored for so long and did such valuable work in helping to unravel the glorious past, and in preserving the arts and customs of the great Polynesian race. I refer to Te Rangi Hiroa (Sir Peter Buck) who was born at Urenui, Taranaki, New Zealand, about 1880 of an Irish father and a full-blooded Maori mother and who became a doctor of medicine of my own alma mater—the University of Otago, Dunedin, New Zealand.

Among the many positions of distinction which he held, including that of a cabinet minister in a New Zealand Government he was professor of anthropology in Yale University (U.S.A.) from 1936 to 1949 and director of that great storehouse of Polynesian knowledge, namely the Bishop Museum of this city of Honolulu, from 1936 to 1951.

Under the circumstances, I thought it would be very appropriate for me as a New Zealander (New Zealand being responsible for the welfare of some three-quarters of the total Polynesian race) to do honor to a fellow New Zealander by telling you something of problems in ophthalmology as they applied to the ancient and modern Maori who, as you know, is the New Zealand branch of the Polynesian family and probably the most advanced of all the Polynesian races. However, on consulting Mr. C. R. H. Taylor, librarian of the Alexander Turnbull Library, Wellington, New Zealand (a library which ranks among the world's greatest and which has among its many and varied books a vast treasurehouse relating to Polynesia) I found that there was practically no specific mention of any eye diseases peculiar to the ancient Maori, except those associated with living in smoky whares (native house). However, the Maori, as known since the advent of the white man, is interesting ophthalmologically not so much from the angle (in contradistinction to his white brother) of the particular diseases from which he does suffer, such as trachoma among the Maoris of northern New Zealand and cataract, as from the angle of the diseases from which he appears to have a much lessened liability to suffer, such as an almost complete absence of glaucoma in all its forms, uveitis, and hyperpiesia.

The chief reason why so little is known about the diseases of the ancient Maori can best be summed up in a quotation from Elsdon Best's *The Maori as He Was*[1] in which he says: . . . "native knowledge of medicine may be described as non-existent in former times. No attempt was made to study it simply because it was believed that sickness and disease were caused by Taua (evil spirits). This formed part of the belief that offenses against the gods are punished in this world and not in the spirit world. And so we see that the superstition-laden religion of the Maori blocked advancement in the science of medicine. The Maori when ill was in the truly unhappy position of being in the care of a priest (Tohunga) instead of a doctor. He was dosed with charms and in-

* Presented at the VII Congress of the Pan-Pacific Surgical Association, Honolulu, November 14-22, 1957. THE JOURNAL is saddened to learn of the death of Dr. Hope-Robertson shortly after this paper was presented. Presumably this is the last paper from his pen.

cantations and mummery until he died or recovered in spite of friends!"

Dr. Thomas W. Bell[2] says: . . . "However, the ancient Maori did use some medicines. Actually, a considerable number of plants have been used by the Maoris but they were used chiefly with the old idea of driving out an evil spirit and the plants used possessed no therapeutic value."

As regards the smoky Maori whare and its association with eye troubles, Elsdon Best[3] says: . . . "By no stretch of the imagination can the Maori whare or native house be viewed as a comfortable place. Most references to eye diseases relate to those caused by the smoky atmosphere in the houses." Thus, Dr. Bell[4] says: . . . "chronic conjunctivitis is very common among the older people. This I attribute particularly to their habit of living so much in smoky houses. Notwithstanding this, their sight is very acute. Purulent ophthalmia is common in children." It seems to me that, probably because of lack of knowledge and dearth of skilled observers, most eye diseases in the ancient Maori were put down to what appeared to the layman to be an obvious cause, namely a smoky whare, when in effect they could have been due to a multitude of other causes.

There is an ever increasing interest in New Zealand history and, through the kindness of Dr. Wright-St. Clair[5] of Hamilton, New Zealand, I am able to quote a previously unpublished reference to eye diseases among the Maoris of the 1840's. This was written by Dr. David Monro (later Sir David) a son of Monro Tertius, the last of the famous Monro Dynasty of Edinburgh whose great grandson Dr. J. Monro—a past president of the Ophthalmological Society of New Zealand—practices as an oculist in Palmerston North, New Zealand.

This is what appeared in *Monro's Journal:*

> Contrary to what I expected, I observed a good deal of disease among such a small number. One at least in eight had inflammation of the eyes and we saw one man who was blind from this cause, and in several others there was thickening and diminution of the clear part of one or both eyes, resulting from long and continued inflammation. I saw ulceration of the cornea in some cases which generally leaves an opacity behind it. As they were told by my companions that I was a doctor several applied to me to relieve them and I was very sorry that I could do nothing for the poor creatures as I had no medicine with me, and even if I had it would have been of very little use. All I could do was to tell them, or signify to them, that their custom of lighting fires in their huts in which there was no chimney and then shutting up the doorway was exceedingly hurtful and I believed it to be the cause of the disease as it used formerly to be and is still common to a considerable extent in the Highlands of Scotland. One or two of the men seemed to assent at once to what I said and remarked that it was "Kapai" (very good).

I cannot believe that the corneal conditions Sir David Monro was describing in that passage arose as a result of living in a smoky atmosphere. Although a medical man, as far as I am aware, he had had no special training and experience in diseases of the eyes.

In my opinion this question as to whether smoky whares gave rise to the obvious corneal conditions from which the Maori suffered from the year 1800 onward, requires much more elucidation. I know of no eye disease peculiar to professional firemen and although a good many Maoris in the remoter parts of New Zealand still live in smoky Maori whares I cannot recall ever seeing Maoris with eye diseases which appear to have been caused by excessive smoke. It is much more probable that the Maori ophthalmia of the early 1800's arose as a result of the decimating Maori wars of Hongi Hika, Te Wherowhero, Te Rauparaha, during which it is estimated some 100,000 Maoris (half the total population) lost their lives, 60,000 alone being killed and eaten by Te Rauparaha and his followers between 1820 and 1843. This appalling slaughter, brought about chiefly by the acquisition of the white man's firearms, together with the increasing contact between the Maori and the white man and chiefly the white man's major diseases, tuberculosis and venereal disease, dur-

ing the years 1800-1840, probably caused far more eye disease than ever did a smoky whare to which the Maoris must have been inured over the preceding 600 years. It is an interesting and intriguing problem and one which I suggest ophthalmic surgeons in all parts of the Polynesian triangle could pursue with profit and pleasure, together with some other problems to which I will allude later.

A knowledge of the type of eye disease from which the ancient Polynesian suffered is necessary before we can assess whether anything in the ancient Maori's diet or mode of life prevented him from suffering from certain ophthalmic diseases or made him more prone to others. And even when we consider the ophthalmic diseases which afflict or do not afflict the modern Maori, I suggest that we have here also a fruitful source of investigation which might give the clue to the causation of certain ophthalmic diseases afflicting the white man. For instance, glaucoma is almost unknown among the present-day Maori, and, as far as I am aware, there is no reference to its existence among the ancient Maori.

I, personally, have no record of any case of glaucoma among present-day Maori patients seen by me over a period of 25 years. In the ophthalmic department of the Wellington Public Hospital, of a total of 170 cases of all types of glaucoma admitted to that department during the years 1953-1956, inclusive, there was not a single case of a Maori. Dr. Violet MacFarlane (personal communication), who practices in Gisborne, New Zealand, has never seen a case of glaucoma in a Maori, either in hospital or private practice.

Dr. C. C. Ring (in a personal communication) says "Nobody in Auckland can recall seeing a case of glaucoma in a Maori."

Although a large number of the modern Maoris are half-caste it may be that to date the white genes have not had time to obtrude their glaucomatous tendencies over the Polynesian genes.

This raises two important points:

1. As in modern parlance neither narrow-angle nor wide-angle glaucoma occurs among Maoris, could this mean the two types of glaucoma had some common factor which was lacking in the Maori? Further investigation over the whole Polynesian triangle might prove worth while.

2. I, personally, believe that glaucoma and all its manifestations is the result of vascular disease. So the lack of cardiovascular disease (to be referred to later) in the modern Maori is surely worthy of investigation. Again, I would like the view of my fellow investigators in other parts of the Polynesian triangle, and for that matter those outside the triangle. The correct answers to some of the questions raised could possibly be of great help in elucidating the cause of the great killer of all as far as eyesight is concerned, namely glaucoma.

However, I feel it my duty to draw attention to certain points as affecting the modern Maori, his life history, and distribution:

a. At the turn of the century—1900, there were about 40,000 Maoris in New Zealand. In 1956 there were very nearly four times as many, namely 150,000 Maoris in New Zealand.

Thus, in 1954, 60 percent of the Maori population were under 21 whereas only 37 percent of the white population were under 21 years. At the same date 37 percent of the white population were over 40, whereas only 15 percent of the Maori population were over 40 years of age.

If we compare the number of deaths in the white population in 1954 per million of mean population for the following diseases, for example, vascular lesions affecting the central nervous system; arteriosclerotic and degenerative heart diseases; hypertension with heart disease, and hypertension without heart disease, with the number of deaths per 10,000 of mean Maori population for the same diseases we find two and one-half times more whites died than Maoris.

Even allowing for great differences in age

groups I am sure that cardiovascular diseases as a whole are much less in the Maori than in the white.

Dr. Theo Hall of Cook Hospital, Gisborne, New Zealand, (personal communication), who sees a large number of Maori patients, says Maoris do not get malignant hypertension and even in cases with arteriosclerosis, hypertensive retinopathy is never seen. In the Hypertension Clinic at Wellington Public Hospital over a period of two years where 352 patients were seen, only eight of them were Maoris. Figured on a population basis this works out at well over three times as many whites as Maoris affected. The New Zealand Official Year Book for 1956,[6] in discussing causes of Maori deaths, says "There is a much lower mortality rate among Maoris for certain diseases which rank high as causes of death among the European population; principal among these are cancer, heart disease, and other diseases of the circulatory system, the group of general diseases which includes diabetes, and the group of diseases of the nervous system which includes apoplexy and cerebral hemorrhage."

b. It could be that what cardiovascular disease is now found among Maoris is due to the introduction of the white genes. Any person in New Zealand since 1926 whose Polynesian blood ranges from half-caste to full-blooded Maori is classified as a Maori.

c. His cardiovascular system could also be affected by the ever increasing change from rural to urban life.

d. Living in cities has meant changes in feeding habits and the fact that the Maori now comes up against many of the stresses of urban life which previously have only afflicted his white brother.

The modern Maori is also much less liable to uveitis in all its manifestations than is his white brother (pakeha).

During 1953-1956 (inclusive), 132 cases of uveitis were admitted for treatment to the Wellington Public Hospital, four of which were in Maoris, but of those four cases two were traumatic in origin. During the years 1936-1956 inclusive I have not seen a case of uveitis in a Maori in my previous practice.

The lack of uveitis among the Maoris, even before the advent of the antibiotics, is all the more remarkable when one considers how many of them are infected with venereal disease.

Dr. Violet MacFarlane (personal communication) of Gisborne, on looking through the last 65 Maori cases in her private practice, finds no case of glaucoma and only one case of iridocyclitis. Twenty-five percent of them were cataracts, 15 percent were refractive errors, and 15 percent were injuries. Why is the Maori so free from iridocyclitis, especially when we consider how many of them die of tuberculosis? Are other members of the Polynesian triangle also relatively free from glaucoma and iridocyclitis? To me, these are problems worthy of investigation.

There is a good deal of so-called trachoma among Polynesian races who come under the control of New Zealand, especially western Samoans. I look upon this Polynesian trachoma as a very attenuated form of trachoma similar to that found in the Fijian and certain northern Maoris. The Fijian trachoma was investigated by Dr. Talbot and myself on behalf of the New Zealand Armed Forces during World War II (see Hope-Robertson and Talbot,[7] New Zealand M. J., 1947). New Zealand and its cities have now become the permanent home of large numbers of Polynesians, apart from Maoris, especially Cook Islanders and Samoans, but I have no hesitation in recommending western Samoans and other Polynesians not actively infected with trachoma for admission as citizens of New Zealand. A useful investigation would be to attempt to link together the various types of so-called trachoma found among the various branches of the Polynesian family (and including certain Melanesians, such as Fijians), and see if there was some common factor as to causation. I highly suspect our old enemies,

dirt and flies, but I am sure from my Fijian experience that, as far as the white man is concerned, the infectivity of this Polynesian trachoma is practically nil. I have never seen a case of trachoma acquired by a white man in New Zealand or Fiji.

All observers in New Zealand note the large percentage of Maoris suffering from cataract. I, personally, operate on many Maoris for cataract and they all seem to do very well.

To date, we have had no reliable information about the prevalence of cataract in the Maori before the advent of the white man. Perhaps the ancient Maori died too early in life for cataracts to become manifest!

Is the large number of cataracts among the modern Maori due to his increasing acceptance of an urban life and an increasing change from his ancient diet? One of our difficulties in arriving at a solution of some of these problems is that only recently have Maori vital statistics been published separately from the white man's.

There would also appear to be a good deal of epiphora and dacryocystitis among the modern Maori, necessitating dacryocystorhinostomy, but to date I have no means of knowing whether it occurs more frequently than in the white man, although I rather suspect it does. It is intriguing to wonder whether the structure of the Polynesian nose plays any part in the causation of dacryocystitis.

Despite the paucity of published references one could spend a long time talking and thinking about ophthalmologic problems in the Maori, and I hope that these few words of mine may stimulate others to see if similar problems exist in other parts of the Polynesian triangle and perhaps even consider them worthy of further investigation.

In spite of the fascinating interest of Polynesian problems, New Zealand has, however, other ophthalmologic problems to which I will now make some brief reference.

The distance between Australia and New Zealand across the Tasman Sea is 1,300 miles—roughly half-way across continental United States.

The two main islands of New Zealand are 1,000 miles long and its climate varies from almost subtropical in the far north to that of dour Scotland in the far south. Its dependencies, consisting of many sparsely populated islands, extend from the equator to the south pole. The estimated population of New Zealand in 1957 (white and Maori) and exclusive of dependencies (population 120,000) is two and a quarter millions, while the total population of the Hawaiian Islands is only one-half million.

Men on lonely Pacific islands leave New Zealand with a known supply of medicines and I and my colleagues are frequently called upon to treat such men by wireless telephone or ordinary wireless. It is marvelous how much can be done if the service is well organized and the last World War taught us a lot about the organization of such a service. So, because of his country's far-flung dependencies, the New Zealand ophthalmologist can be asked to prescribe goggles for somebody proceeding to the south pole; suitable glasses for a body of men about to sojourn near the equator; to proceed (with all the necessary apparatus) to some tropical isle and there do a series of cataract operations; to try to determine whether the fundus changes seen in a Cook Islander are due to yaws or syphilis; or treat an eye injury sustained by a member of the meteorologic staff on lonely Campbell Island in the far south. However, by careful preparation and especially the skilful use of the wireless or wireless telephone it is amazing how well some ophthalmic diseases can be treated in lonely outposts and how it is possible to arrive at quick decisions as to whether or not flying boats, air planes or even surface craft should be sent, sometimes at great cost), with skilled assistance.

On the other hand, there are certain ophthalmic problems which are peculiar to New Zealand. New Zealand is a primary producing country and depends for its prosperity

entirely upon the money it receives for its wool, meat, dairy products, fruit, and so forth, and although secondary industries are increasing at a great rate they only supply our own needs.

The total area of New Zealand, exclusive of island territories, is 103,736 square miles, compared with the total area of the Hawaiian Islands—6,500 square miles.

Rural population in New Zealand is defined as those who live in the towns of less than 1,000 people down to those who live in the country, while urban population is, of course, those who live in cities and towns whose population is above 1,000.

G. J. R. Linge says, in the *New Zealand Geographer*:[8] "155,000 or 19.2 percent of the employed population of New Zealand are engaged in manufacturing industries, while 137,000 or 17 percent of all employed workers are engaged in farming."

There are 10,334 factories in New Zealand. The Factories Act of 1946 defines a factory as any building, office, or place in which two or more persons are employed directly or indirectly in any handicraft or in preparing or manufacturing goods for sale.

The outstanding feature of manufacturing in New Zealand is the very large number of small units. Of 10,334 factories in New Zealand 8,939 such factories employ 20 or less workers. However, 45 percent of all workers are employed in units having more than 50 workers.

Of the total population, 38.1 percent, including Maoris, is rural and 61.9 percent is urban. The Industrial Hygiene Section of the Health Department of New Zealand has done good work in the larger factories, and by efficient preventive work we now have fewer major eye injuries arising in the larger factories. We now find it is the small factory —the one which employs under 10 men— from which come most of our major eye injuries. Such factories are far too small to employ a trained optical expert. In my opinion the only answer is repeated inspection and education. A travelling optician's van might help very considerably. Unfortunately, New Zealand has no means of forcing workmen to take preventive measures.

When we come to consider rural workers we find that on a great many farms, especially dairy farms, the whole family, (who, of course, are not assessed as farm workers) also work on the farm. There are 66 m. acres in New Zealand of which 43 m. were assessed in 1955 as being in occupation.

There are 90,000 holdings of one to 10 acres up to over 50,000 acres (52); there are 79,000 holdings of which none is greater than 640 acres.

The numbers on a modern, average New Zealand farm would equal the numbers employed in an average New Zealand smaller factory.

All farms nowadays are veritable hives of machinery. Practically all milking is done by machines—very few farms are without a tractor (deaths from overturning of tractors are becoming very alarming in New Zealand); New Zealand has pioneered the world in aerial top-dressing and many farms have their own landing strips and all that goes with servicing aircraft. All this machinery requires care and attention and, for purely economic reasons, the modern farmer must be, in many cases, his own mechanic. In other words, the modern farm is now, to all intents and purposes, a small factory with those who work in it, in many cases, ill prepared for such work and certainly with no idea of the inherent dangers of serious eye injury when engaged in such work without adequate eye protection. Therefore, we now find that a great many of our serious eye injuries come from farming units.

It can be said that there are 90,000 farming units as against 10,000 factories in New Zealand, but it must be remembered that, although the amount of mechanical work done by the modern farmer is ever increasing, nevertheless the amount of time he would spend on purely farm mechanics, that is, repairing of farm machinery where eye ac-

cidents are most likely to occur, would be very small when compared with that of a mechanic in a factory and working a 40-hour week.

In going into the causation, particularly that of intraocular foreign bodies on farms, we find, of course, that the use of a cold chisel and a hammer and no attempt at eye protection is far and away the most common cause of this serious ocular injury.

Fencing operations are also a further serious cause of eye injuries.

So far little has been done to educate the farmer in the control of eye accidents. I suggest appropriate motion pictures to be shown at farmers' clubs, which are very active bodies in New Zealand, and also at agricultural universities and high schools.

Another common rural injury in New Zealand is that caused by the spine of a gorse or whinbush. Gorse grows wild in New Zealand, having been introduced by the early settlers to provide cheap fencing, and gorse cutting has become a regular occupation of many rural New Zealanders. We, as ophthalmologists, see many accidents caused by gorse spines penetrating the cornea, the tip of the spine projecting into the anterior chamber. Most rural doctors are aware of the dangers associated with faulty removal of gorse spines and send their cases to an ophthalmologist, if possible. Careful and correct technique for the removal of these spines usually results in their removal without any permanent damage, except a small residual corneal opacity.

In proportion to its population, New Zealand is the worst country in the world for the incidence of hydatids. Large numbers of New Zealanders lose their lives every year through this disease, and many more are incapacitated for long periods, and some for the rest of their lives. The occurrence of this disease is a blot on our so-called civilization and arises wholly and solely through the apathy of the average farmer. But, as so many animals are affected, with the result that many livers and other organs now have no selling value, the farmer is beginning to find that his purse is becoming touched and that fact, more than anything else, will make him wake up and do something about this very serious problem.

The health department and government have been doing what they can; every farmer is issued a sufficient quantity of a dosing substance to dose his dogs every time he receives his dog license once a year, and he is repeatedly warned (in fact it is an offense but difficult to enforce) that he must not feed offal to his dogs.

The application of these two simple measures would rid New Zealand of hydatids. Yet the farmer refuses to carry them out. I feel that if it were possible to charge some farmer with murder when the next person dies of hydatid disease something might really happen, although in a country like New Zealand which depends for its very existence on its farming it is almost as serious a crime to steal a sheep as it to kidnap a human being.

Despite the prevalence of hydatid disease, so much so that when confronted with a swelling in any portion of the body the average New Zealand doctor first thinks of a hydatid cyst, I personally have never seen a hydatid cyst in an eye or in the orbit, and I know of no New Zealand ophthalmologist who has had a case of hydatid disease in the eye or its adnexa. This is rather interesting because such cases have been recorded in other countries.

These are some of the problems of New Zealand ophthalmology but, when reduced to their bare essentials, we find they all have one common factor and that is, lack of the necessary finance for their elucidation or elimination. We realize that this is a common cry the world over that in a young country which has many things to do with its money, medical research usually comes off a poor second. This applies especially to ophthalmologic research which seems to be the Cinderella when it comes to apportioning available funds.

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Zealand is trying to educate the people and government of New Zealand as to the necessity for investigation into many ophthalmologic problems, pointing out that we have the men who are capable of undertaking these investigations, but I personally hope also that some of those present today whose countries are interested in members of the Polynesian triangle will be sufficiently stimulated to urge investigations in their appropriate spheres. I am sure there are ophthalmologic problems in the Polynesian- triangle, the solution of which could be of inestimable value to the whole human race.

References

1. Best, E.: The Maori as He Was. 1952, ed. 3, p. 135.
2. Bell, T. W.: New Zealand M. J., Jan., 1890, p. 135.
3. Best, E.: The Maori as He Was. 1952, ed. 3, p. 239.
4. Bell, T. W.: New Zealand M. J., Jan., 1890, p. 143.
5. Journal in possession of Miss L. C. Monro of Palmerston North, New Zealand, and quoted with consent of R. E. Wright-St. Clair, official biographer of Sir David Monro.
6. New Zealand Official Year-Book, 1956, p. 108.
7. Hope-Robertson, W. J., and Talbot, L. S.: Investigation of epidemic eye disease in Fiji. New Zealand M. J., **46**:252 (Apr.) 1947.
8. Linge, G. J. R.: Location of manufacturing in New Zealand. New Zealand Geographer, **13**:1 (Apr.) 1957.

PROBLEMS RELATED TO NASAL-LACRIMAL SURGERY*

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Three cases with common pathology in and around the nasal lacrimal passageway will be presented. It is the purpose of this paper to show how cases of this type can be misdiagnosed or mismanaged.

Case 1

A 39-year-old nurse was first seen on March 28, 1953, with a diagnosis of epiphora of the left eye. At that time a mild epiphora was treated by the use of mild astringent drops and sodium sulfacetimide ointment.

The tear passageway was noted to be patent and irrigated through rather easily. There was no swelling in the region of the sac. No masses were felt. The patient was seen again two years later at an informal consultation in the hallway of the hospital. At that time there was a slight swelling about the size of a pea over the area of the sac.

The patient asked about treatment and, when she was told that she might have to be hospitalized for further studies and treatment, she asked whether this might be done at some hospital other than our own. For personal reasons, she wanted no studies and definitely no operation done in our own hospital.

For this reason, I suggested the name of a colleague in a far corner of the state who had a large series of successful operations on the nasal-lacrimal passageways, using polyethylene tubing. Furthermore, he inserted this tubing in his office on an outpatient basis. It was my impression from the cursory examination in the hallway that this patient probably had a dacyrocystitis and, considering all the factors involved, I felt my colleague would find this an ideal case for the use of polyethylene tubing.

I did not see the patient until about six months ago when she told me that she had her eye operated on in still another corner of the state by an ophthalmologist other than the one I had suggested. In brief, the admission report to this other hospital read as follows:

"This 39-year-old nurse had had tearing off and on over a period of several years. The patient gave the history of a swelling in the region of the nasal lacrimal sac which filled and collapsed on massage. X-ray studies including lipiodol injection of the sac showed patency of the sac and filling as noted. The patient had been given a nose and throat clearance by an otolaryngologist. The lipiodol studies showed no filling in the area of a rubbery mass just below the sac region lying near and firmly fixed to the nose.

"Operation on April 2, 1956, consisted of dissecting the tear sac and a tumor mass which was connected to the sac. The tumor came out intact with its capsule unbroken. Two polyethylene bougies passing through the upper and lower puncta into the nasopharynx, were inserted in an attempt to

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maintain lacrimal drainage. Healing was uneventful. The patient was discharged with the bougies in place.

"The pathologic report read as follows:

"Gross examination revealed a two-cm. well-circumscribed, irregularly round hard mass of tissue. It was white, encapsulated, and homogenous. On one surface a portion of the lacrimal sac and/or duct was attached. The impression of the pathologist was 'neurofibroma' in the lacrimal sac region. Because of the microscopic appearance, some pathologists may regard it as a plain fibroma. Its benign nature is obvious."

Comment

The lessons to be learned from this case are:

1. It is never possible to make a diagnosis without a complete examination and necessary studies.

2. Polyethylene tubes and similar plastic tubes inserted into the sac without direct examination of the involved area can sometimes lead to unforeseen troubles, among which may be a nonspecific granuloma of the lacrimal sac harboring polyethylene tubing, such as was reported by Dr. Weizenblatt. Body fluids at body temperatures, tears, purulent secretion, and enzymes over a long period of time can dissolve the tubing and cause abscesses and granuloma.

Case 2

The second case is that of a 24-year-old Negro who was admitted to University Hospital as an emergency case after midnight with extensive lacerations to the right face, upper and lower lids, and the nasal lacrimal passageways.

On admission, the patient, who had been in a severe auto accident, was in a state of shock. He had been given shock treatment and, since the general surgeon felt that his eye had been severely damaged, he was turned over to us for treatment. In the operating room the patient was maintained on his infusions, and the operation proceeded under general anesthesia. Our operative report read:

"The patient was draped in the usual manner and seven liters of warm, sterile saline in a continuous drip were used to irrigate out of the extensive wound chips of paint, pebbles, grit, and other debris. This cleansing of the wound consumed one hour. The wound extended in a hockey-stick fashion, starting from a point on the right face opposite a point inferior and slightly anterior to the right ear. This laceration was then carried all the way supernasally along the course of the anterior facial artery and veins, which fortunately were not damaged. The lower lid of the right side was lacerated longitudinally into two or three ragged pieces and a deep cut in the upper lid just above the supraorbital ridge, extending for about one cm. in length and down to the frontal bone, was present. As previously described, the facial laceration had been so deep as to expose the periosteum of the maxillary bone extending laterally so that full exposure of the anterior skeletal portion of the face could be seen.

"When all foreign particles were cleaned out as thoroughly as possible, 2-0 chromic catgut was used to anchor subcutaneous tissue to deep fascia and periosteal tissue below. Likewise, 4-0 chromic catgut was used to suture in interrupted fashion the more superficial layers of subcutaneous tissue. Interrupted 5-0 silk sutures were used to approximate the lacerated skin edges.

"The reconstruction of the lower eyelid required an extensive procedure, particularly the medial canthus, the reconstitution of which entailed the suturing of several shredded pieces of skin and tissue. No attempt was made to reconstruct the lacrimal apparatus because of the swelling and severe fragmentation of tissue in this area. It is believed that the sac and nasal lacrimal duct were preserved, although it was felt that the tear passageways were in all probability severed along the canaliculus.

"Upon completion of the skin sutures two rubber drains were inserted into the wound, one inferiorly and one midway between the medial canthus and the most lower portion of the wound. These will be withdrawn in two days. Gauze squares soaked in 1/1,000 colorless Zephiran were then used immediately over the wound and fluffs and a pressure dressing were applied on top of these Zephiran patties. Ace bandages completed the pressure dressing. Sodium sulfacetimide ointment (10 percent) was instilled into the reconstructed sac.

"Prognosis for a good result in the lid reconstruction is guarded in view of the extensive amount of repair and the extensive amount of foreign particles of dirt which had contaminated the wound. It is highly possible that future plastic procedures may be necessary to achieve a good cosmetic result."

At the time of operation no attempt was made to reconstruct the lacrimal apparatus, which it was felt in all probability was severed along the canaliculus. The feeling at that time was that the sac and nasal lacrimal passageway were preserved. The procedure of closing the wound and the marked swelling and loss of tissue in the area of the nasal lacrimal passageways did not permit a reconstruction of this area at that time.

Postoperatively the patient was in a state of semiconsciousness for two days. After discharge from the hospital, the problems from an eye standpoint were those of epiphora and lateral displacement of the medial canthal fold. It was impossible to probe the nasal lacrimal passageways on this side and therefore to irrigate them from either the upper or lower passageways. In a second operation, investigation of the tear passageways showed that the sac was so completely destroyed that attempt

at reconstruction was considered inadvisable. The medial canthal ligament was displaced laterally. A dacryocystectomy of the remaining tissue was performed.

A wire suture was placed through the torn medial canthal ligament and as much of the surrounding scar tissue as could be excised was removed. Using the method of Converse and Smith for anchoring the canthal ligament, the wire suture was drawn taut, but broke. Finally it was replaced with a very strong chromic suture.

Comment

Postoperatively, there was some cosmetic improvement but the canthal fold was still displaced laterally. Of course, there was also epiphora. The patient refused further surgery and was lost for further follow-up.

In retrospect, ideally, some attempt should have been made at reconstructing the tear passageways with polyethylene tubing used temporarily or some modification at the second operation. This was impossible at the first operation. Whether further excision of the keloid scars and greater mobilization laterally would have been helpful in restoring the proper position of the canthal fold is open to question.

Case 3

The third case represents that of a patient who was referred to us from the general surgical service after inadequate excision of a basal-cell tumor originating immediately over the nasal-lacrimal passageways. The recurrent tumor failed to respond to X-ray therapy and, therefore, the patient was referred to our service for exenteration. The only reason that the patient consented to removal of the tumor and the eye was that the odor of this wound was most objectionable to his family who were shouldered with the responsibility of his care. Excision of the tumor involved a broad exentration.

Postoperatively, the sinus infection and odor were controlled by the use of gauze saturated with Chloresium,* a chlorophyll derivative used during the Korean war for extensive wounds. Chloresium solution (plain) is completely nontoxic and nonirritating and may be employed freely. It can be applied full strength to the affected areas as a continuous wet dressing.

Comment

The lessons to be learned from this case are:

1. A thorough knowledge of the nasal lacrimal passageways is most essential.

2. For odor and similar problems, dressings incorporating chlorophyll derivatives are most helpful.

3. Tumors in the area of these passageways should be removed completely and widely, sacrificing all the passageways and the surrounding tissues including the bony structures and the eye, if necessary. The use of a prosthesis incorporating the idea of a Manchester sponge attachment can hide the defect.

Summary

In summarizing these cases, all show that a thorough knowledge of the nasal-lacrimal passageways is most essential for all surgeons and especially the ophthalmologist who, in the end, is most qualified to assume the responsibility of cases involving these areas. When possible, if proper treatment is to follow, thorough studies must be made. Lipiodol studies of suspected cases of dacryocystitis are sometimes helpful in showing the borders of the tear passageways. The insertion of polyethylene tubes instead of a dacryocystorhinostomy can lead to problems other than the "meticulous care and angelic patience necessary to the success of the use of these tubes." When necessary, operations on the tear passageways must include biopsy.

In restoring a severed canthal ligament in the presence of recurrent dacryocystitis, a dacryocystorhinostomy combined with reattachment of the medial canthal ligament to the bony wall is the operation of choice. If scar tissue is extensive, it must be excised; complete freeing of the surrounding tissue is necessary to achieve a pleasing cosmetic result.

If a malignant tumor in or near the nasolacrimal passageway is suspected, wide excision of the entire tumor area, sacrificing the nasal lacrimal passageways completely, is indicated.

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* Chloresium Solution-plain. Rystan Company, Inc., Mount Vernon, New York.

References

Converse, J. M., and Smith, B.: Canthoplasty and dacryocystorhinostomy in malunited fractures of the medial wall of the orbit. Am. J. Ophth., **35**:1103-1114, 1952.

Jones, L. T.: Personal communication.

———: Epiphora: II. Its relation to the anatomic structures and surgery of the medial canthal region. Am. J. Ophth., **43**:203-212, 1957.

Manchester, T.: Sponge attachment for epiphora. Arch. Ophth., **57**:739, 1957.

Spaeth, E. B.: Carcinomas in the region of the lacrimal sac. Arch. Ophth., **57**:689-693, 1957.

Weizenblat, S.: Nonspecific granuloma of lacrimal sac harboring polyethylene tube. Arch. Ophth., **58**: 130-134, 1957.

TREATMENT OF HERPETIC KERATITIS BY CORNEAL TRANSPLANTATION*

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With the increasing interest in therapeutic keratoplasty of the past decade it was natural that its application to the chronic and recurrent diseases of the cornea should be of major concern. It was fortuitous, also, that during this same period of intense activity in the field of therapeutic keratoplasty there came to the attention of many ophthalmologists and virologists the fact that herpes simplex infections of the cornea, always a major problem, had undergone a change in frequency and in severity which now made it the most important infectious disease of the eyes on the North American continent.[1] It is now the most frequent cause of visual loss due to corneal opacities, and therefore the most frequent indication for keratoplasty in this country, with possibly the exception of keratoconus.

The change in the character of the disease is expressed in the increased number of bilateral cases, the increased number of severe cases leading to stromal necrosis and perforation, increased frequency of chronicity and relapse, and probably an over-all increase in the incidence of the disease. Although some subepithelial involvement of Bowman's membrane is present in practically all cases of herpetic keratitis, even in the earliest dendritic ulcers, involvement of the stroma appears to be becoming more frequent, having been observed in 30 percent of the large series studied by Thygeson and his co-workers.[2]

* From the Division of Ophthalmology, Department of Surgery, Stanford University School of Medicine, and the Veterans' Administration Hospital, San Francisco. I am indebted to Col. Reed Kelly, (MC), Eye Section, Letterman Army Hospital for permission to report cases operated there. Presented before the VII Congress of the Pan-Pacific Surgical Association, Honolulu, November 14-22, 1957.

Methods of treatment

It is not within the scope of this paper to review the entire complicated problem of the immunology, clinical manifestations, and therapy of herpes simplex infections. Suffice it to say that at the present time there is no evidence that an increase in circulating antibody titer will prevent recurrences of herpetic keratitis[3] or that such recurrences will give rise to an increased antibody titer.[4] On the other hand the local tissue antibodies are increased by an attack of keratitis and this increase appears to render the tissue relatively insusceptible to further injury by the herpes virus, at least for a period of time. This may be of considerable importance in explaining the effects of corneal transplantation in some cases of recurrent or chronic keratitis, as we shall note later.

Chemotherapy and antibiotics have been shown to be of no value in the treatment of herpetic keratitis, except for controlling the secondary bacterial or fundus infections which often take place in such corneas. Aureomycin was believed by Ormsby to be

of some value in some cases of herpes simplex conjunctivitis but is now generally recognized as ineffective in the treatment of the keratitis. Total removal of the infected epithelium in early cases of dendritic keratitis and destruction of the virus with iodine or other agents while it is still limited to the superficial layers appear to be the only useful methods at our command. In cases in which the deeper layers of the cornea are involved—such as in disciform keratitis, chronic stromal keratitis, and in cases of metaherpetic keratitis (chronic recurrent superficial ulceration)—the only effective method of controlling the recurrences has been suggested by Rake[4] as the total removal of the entire cornea by corneal transplantation. This radical approach has fortunately not gained widespread acceptance and its complications are certain to be worse than those of the disease. Nevertheless there are numerous cases of chronic and recurrent keratitis in which partial or subtotal corneal transplantation appears to offer therapeutic advantages.

Indications for keratoplasty

It has been found convenient to divide the cases of herpetic keratitis in which keratoplasty is indicated into three groups:

1. Those with inactive postherpetic scars, either superficial or stromal, in which transplantation is performed primarily for optical purposes.

2. Cases of prolonged recurrent episodes of superficial keratitis either diffuse or circumscribed as in metaherpetic keratitis, or deeper lesions recurring over many months or even years.

3. Cases of chronic stromal keratitis which persist over many months, with or without an associated uveitis, and leading frequently to stromal necrosis and perforation.

The first group would ordinarily be considered as examples of optical keratoplasty rather than therapeutic. However, the increasing frequency of reactivation of apparently quiescent corneal lesions after a period of many years suggests that this group also may appropriately be considered as therapeutic keratoplasties, the probability of recurrence being so great.

The relationship of therapy with the corticosteroids to the increasing incidence of chronicity and perforation has been a matter of great concern and has been commented upon at length by Thygeson, Kimura, and Hogan. The picture is not at all clear. Instances of marked improvement in cases of stromal keratitis and even of dendritic keratitis following hormonal therapy are well known. On the other hand, I have personal knowledge of several cases of perforation in which no steroids were used at any time. In contrast to this there are numerous cases now on record in which fresh dendritic lesions appeared in the course of a relatively benign stromal keratitis treated with topical steroids. To balance this there is described in this report a case (Case 15), in which dendritic lesions recurred both in the recipient and the donor cornea where no steroids were being administered.

This uncertain state of our knowledge of the role of the corticosteroids in herpes of the cornea is of particular interest to those performing therapeutic keratoplasties for this condition because it is desirable to administer such steroids in the postoperative period to reduce the postoperative inflammatory and vascular reaction, and to minimize the possibility of an immune reaction between the host and the donor tissue.

I may note here, parenthetically, that such topical steroid therapy and, in a few cases, systemic therapy has been carried on postoperatively in every one of my cases in which keratoplasty was performed and that in no case was activation of the disease or recurrence noted during the period that such treatment was in force. It should be emphasized, however, that this treatment was carried on under careful supervision and was terminated promptly as soon as the danger

cal" or "therapeutic" cannot be made strictly. in the last type of case the descemetocele is

period for severe immune reactions between host and donor was passed—usually five weeks.

Effects of keratoplasty on herpetic corneal lesions

Granted that other methods of treatment are ineffective and that replacement of the diseased tissue is the only method of therapy available at present in the cases of severe chronic and recurrent herpes I have described, how does such replacement bring about an arrest of this disastrously destructive and resistant infection? Several mechanisms suggest themselves:

1. The removal of diseased or necrotic tissue.
2. The removal of the infective virus.
3. There may be a temporary or permanent reduction in vascularity in the area, which brings about a diminution or inhibition of the allergic reaction.
4. There is possibly a beneficial effect from the introduction of fixed antibodies in the donor tissue.
5. There is the possible biologic effect of the introduction of new tissue. This concept has been supported particularly by some European investigators, notably Filatov.

In reviewing the results of therapeutic keratoplasties during the past decade one quickly discerns that therapeutic keratoplasty at the present time is in much the same state as was optical keratoplasty 20 years ago. The series of cases reported are relatively small and case reports are generally sketchy.

Since the criterion in therapeutic keratoplasty is the relief of symptoms or arrest of the disease, rather than visual improvement, the period of observation is often rather short and the results are too often described in subjective rather than in objective terms. With corneal herpes, in which the hypesthesia of the cornea frequently lulls both patient and oculist into a false optimism, this can be particularly misleading. Nevertheless, of all the types of cases undergoing corneal transplantation for therapeutic purposes the one type which all authors agree upon as yielding good results is herpetic keratitis.

Chronic herpetic keratitis, metaherpetic ulcers, and disciform keratitis are generally agreed upon as representing the most frequent and the most suitable indication for therapeutic corneal grafting. In a total of 13 cases Paufique[5] reported good results in all but one. Franceschetti[6] expressed the opinion that this type of active keratitis represented the most favorable indication for therapeutic keratoplasty. Gallenga[7] listed herpetic keratitis, particularly of the recurrent type, as a major indication for a lamellar graft. Foster,[8] Giani,[9] Hobbs,[10] and Paton[11] have also reported good results in chronic herpetic keratitis. More recently Hogan[12] has reported on 18 patients with various types of corneal herpetic affections and considered the results "for the most part gratifying." He concluded that "keratoplasty is a satisfactory procedure for the treatment of diffuse and disciform scars of the cornea due to herpes infections, chronic post-herpetic ulcers, and persistent post-herpetic keratitis."

Material of this report

The observations presented in this report are based upon 38 keratoplasties performed in 31 patients with various forms of corneal herpes. Fifteen of the operations were performed primarily for visual reasons. These were healed, inactive, herpetic scars, either diffuse or disciform. Fourteen of the 15 were penetrating kertoplasties and one was lamellar. Twenty-three operations were performed primarily for therapeutic reasons, that is, for a chronic or subacute herpetic keratitis which failed to heal over a period of many months, for frequent recurrences of a herpetic keratitis, or for a necrotizing deep keratitis which threatened to perforate. Of these 23 operations, 16 were penetrating keratoplasties and seven were lamellar keratoplasties. In many instances, of course, the designation of the transplantation as "opti-

cal" or "therapeutic" cannot be made strictly. Often both effects are intended. However, in any case in which the keratitis was not completely inactive, or in any case in which frequent recurrences had taken place up to the time of operation, the operation has been classified as "therapeutic." For brevity, the cases have been presented in tabular form wherever possible (tables 1, 2 and 3).

1. Postherpetic opacities

This group includes cases in which the keratitis was completely inactive. Some of these were superficial scars, either diffuse or central, producing a marked visual defect. Others were stromal opacities, usually disciform in type, although in some instances the disciform character of the lesion was obscured by secondary degenerative changes, such as calcareous or fatty degeneration. Operation in these patients was performed primarily for optical purposes. In these patients the keratoplasty was done not less than a year after all activity had ceased. Because the objective in this group of patients was visual improvement, penetrating keratoplasty was carried out in all but one case, regardless of whether the opacity was superficial or stromal.

The possibility of a good visual result approaching normal vision, appears to be much better with penetrating keratoplasty in properly selected cases, in my experience. The slightly greater hazard inherent in a penetrating operation has seemed to me to be warranted in such healed cases. On the other hand, where activity of the keratitis is still present, or where there is a complicating uveitis present, lamellar keratoplasty is to be preferred whenever feasible. Exceptions to this rule are (a) the circumscribed chronic stromal lesion, which does not extend to the limbus and can be completely removed by a penetrating graft up to seven mm. in size, and (b) cases of necrotizing deep keratitis in which a prominent descemetocele is present, so that a lamellar graft is technically very difficult.

When lamellar keratoplasty is performed in the last type of case the descemetocele is frequently ruptured, making accurate coaptation of the lamellar disc difficult. If the lamellar dissection is completed without rupturing the descemetocele, its prominence likewise makes it difficult to achieve smooth coaptation of the graft to the underlying recipient cornea.

The results of keratoplasty in this group of healed herpetic lesions of the cornea are presented in Table 1. The follow-up after keratoplasty has been from one to five years. Since the primary purpose of the keratoplasty in this group is optical, the preoperative visual acuity, postoperative acuity, and the refractive error, when known, are presented. The results are good and are comparable to those in similar opacities of other etiology. The only cases deserving special comment are the three in which recurrence of herpetic keratitis took place (Cases 6, 8, and 15):

Case 6

Mrs. H. R., aged 70 years, had defective vision in both eyes due to recurrent episodes of herpetic keratitis which had occurred over a period of about 15 years up to 1950. The vision of the right eye was 3/200 and of the left eye 1/200. The right cornea presented a central superficial opacity, moderately vascularized from the nasal side. The left cornea had a large dense disciform opacity with some calcific degeneration. A few small vessels were present in the midstroma. The disciform lesion was eccentric in the cornea, being situation to the nasal side, so that its border came with two mm. of the limbus.

Corneal transplantation was performed in the left eye in July, 1956, using a seven-mm. disc with 12 direct sutures. To avoid placing the line of union closer than two mm. from the limbus on the nasal side, it was necessary to leave a very minute piece of the disciform opacity at the 9-o'clock position, where a vessel also entered the opacity. Following the operation healing took place uneventfully except at this point where the opacity had not been completely removed. A low-grade keratitis involving epithelium and superficial stroma appeared at this point about four weeks after the keratoplasty and persisted for approximately five months. The epithelium of the graft adjacent to the area underwent repeated episodes of edema and erosion and finally healed under treatment with topical fluorohydrocortisone.

Case 8

Mr. J. L., aged 65 years, had a diffuse superficial

TABLE 1

KERATOPLASTY IN INACTIVE POSTHERPETIC OPACITIES: GROUP I

Case No.	Patient, Age, Hosp. No.	Diagnosis	Vascularity	Duration	Type of Keratoplasty	Vision and Refraction		Period of Observation	Complications	Remarks
						Preoperative	Postoperative			
1.	R.B., 32 MZH 47196	Disciform keratitis, left eye	++	4 yr.	Penetrating 7 mm.	4/200	20/20 −2 (+6.50 sph)	2 yr.	Iris adhesions inferior borders from 5–7 o'clock	Graft transparent
2.	L.I., 40 SUH #92361	Disciform keratitis, left eye	++	1 yr.	Penetrating 6.5 mm.	20/800	20/30 (+3.50 +3.50 ×90)	4 yr.	Edema of graft 1 mo. postop. Cleared in 6 mos.	Graft transparent. Fine folding of Descemet's
3.	P.K., 70 SUH E732357	Diffuse nebula, left eye (macular hemorrhage, right eye)	—	10 yr.	Penetrating 6.5 mm.	20/40	20/80 (−1.50 +2.00 ×65)	2 yr.	None	Partial amblyopia, Graft transparent
4.	L.B., 36 SUH E140451	Disciform keratitis, left eye	+	2 yr.	Penetrating 7 mm.	20/200	20/30 (+2.00 +2.50 ×105)	1 yr.	None	Graft transparent
5.	M.Z., 39 SUH E611759	Bilateral disciform keratitis	++	6 yr.	Penetrating 7 mm. (R.E.)	20/200	20/40 −1 (+2.50 sph)	2 yr.	Severe late edema of graft cleared under topical prednisolone	Graft transparent except temporal one-third which is hazy
6.	H.R., 72 SUH E134168	Disciform kera-	+	7 yr.	Penetrating 7 mm. (L.E.)	1/200	20/30 (−0.50 +4.00 ×140)	2 yr.	Small recurrence of keratitis at border of graft where previous lesions extended to limbus	Healed without impairment of graft. Topical fluorohydrocortisone
7.	F.K., 40 MZH 89703	Disciform keratitis, bilateral	++	14 yr.	Penetrating 8 mm. (L.E.)	20/200	20/800	2 yr.	Severe immune reaction with chronic edema of graft	Retransplant done one year later—similar late edema. Vision 20/400
8.	J.L., 63 SUH E131539	Metaherpetic keratitis, R.E. (L.E. blind)	+	10 yr.	Lamellar 7 mm.	2/200	20/70	2 yr.	Recurrence of keratitis and perforation at border of graft after 2 yrs.	Penetrating 8 mm. transplant done
9.	E.H.P., 27 SUH E129797	Opacity under lamellar graft done for chronic herpetic keratitis	++	1 yr.	Penetrating 8 mm.	20/200	20/30 (+1.00 +2.50 ×75)	1 yr.	None	Graft transparent. Had herpes labialis 5 mos. postop. Eye was not involved
10.	G.T., 16 SUH E71166	Diffuse superficial opacity L.E.	+	10 yr.	Penetrating	20/200	20/50 (−5.00 sph)	5 yr.	Mild central edema of graft for 4 mos. postop.	Small central opacity of graft
11.	S.D., 31 LGH	Disciform keratitis, R.E.	+	3 yr.	Penetrating 6.5 mm.	H.M.	20/100	2.5 yr.	Moderate postop. edema	Graft slightly nebulous
12.	S.T., 3½ SUH E139280	Disciform keratitis, R.E. Total opacity of cornea	++	3 yr.	Penetrating 7 mm.	H.M.	20/40+	1 yr.	Iris incarceration first day postop. Iris replaced	Patient is 3½ yrs. old. Keratitis occurred age 6 mos.
13.	L.R., 21 SUH E134319	Superficial opacities from dendritic keratitis R.E.	−−	13 yr.	Penetrating	20/400	20/25 (−1.50 +4.00 ×95)	2 yr.	None	
14.	E.B., 65 VAH 90,778	Metaherpetic keratitis, bilateral	+	14 yr.	Penetrating 7 mm., L.E.	20/800	20/80	1 yr.	Senile cataract present	Cataract extraction after 6 mos. Vision corr. 20/40
15.	J.B., 16 MZH 95164	Disciform keratitis, bilateral (age 1½)	−−	12 yr.	Penetrating 7 mm., L.E.	5/200	20/25 (−1.50 +2.50 ×65)	2 yr.	Dendritic keratitis involved recipient cornea and graft 20 mos. after operation. Treated with Tr. Iodine	Smaller numular opacities of graft. Vision 20/25

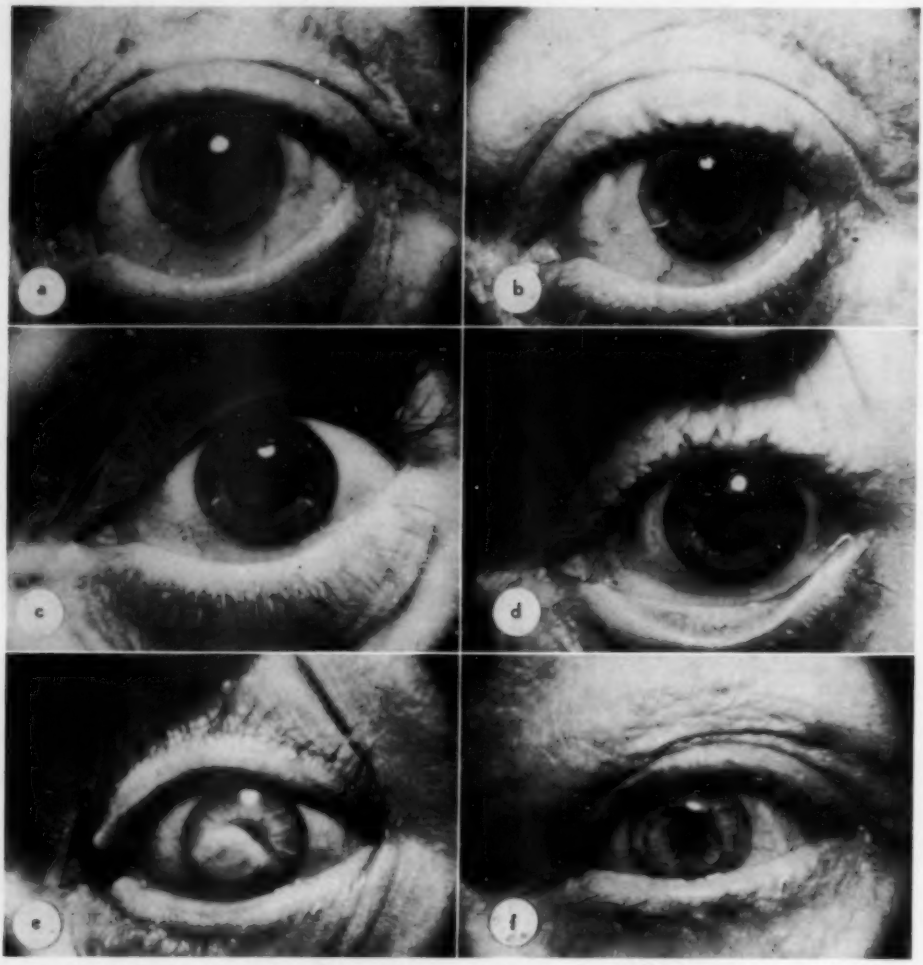

Fig. 1 (Fine). (a) Case 3, Group I. Favorable case of healed superficial herpetic keratitis. (b) Case 3, Group I. Transparent penetrating graft two years after operation. (c) Case 4, Group I. Healed herpetic disciform keratitis. Opacity reaches limbus below. (d) Case 4, Group I. Transparent penetrating graft, seven mm. in diameter. (e) Case 6, Group I. Healed disciform keratitis with a calcareous degeneration. A few vessels enter the opacity from the nasal limbus. Corneal sensitivity poor. (f) Case 6, Group I. Transparent graft one year after operation. A small recurrence of the keratitis appeared at the nasal side adjacent to the narrow remnant of the disciform lesion.

opacity of the left eye from repeated attacks of herpetic keratitis over 10 years. Vision was reduced to 2/200. The right eye had been blind for many years, following an injury. Because the patient was elderly and monocular, lamellar keratoplasty was chosen as less hazardous than a penetrating graft. Healing was uneventful but a faint opacity developed between the graft and the recipient stroma so that vision was never better than 20/70.

The patient lived in an isolated area and was not seen for two years. At that time the lamellar graft was still slightly nebulous as before. In addition, there was an arcuate area of epithelial and stromal edema at the temporal margin of the graft and a descemetocele about two mm. in diameter, at the nasal margin. The entire cornea showed numerous fine vessels running to the line of union between the recipient cornea and the transplant. It was dis-

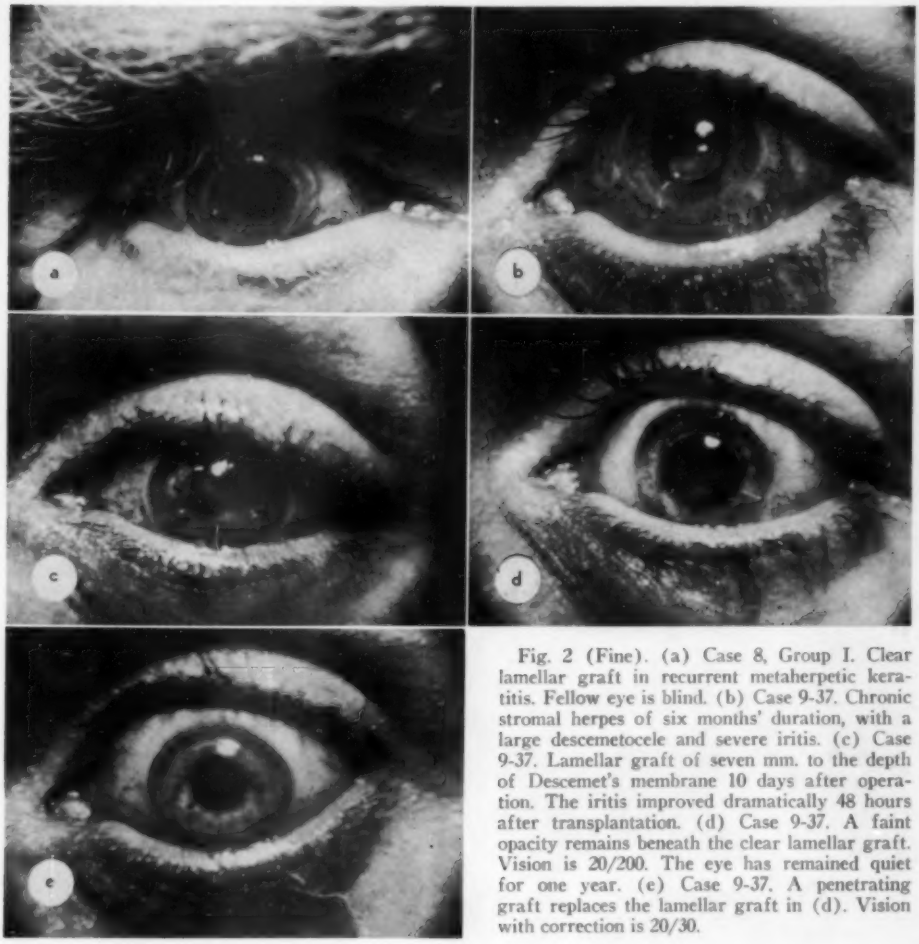

Fig. 2 (Fine). (a) Case 8, Group I. Clear lamellar graft in recurrent metaherpetic keratitis. Fellow eye is blind. (b) Case 9-37. Chronic stromal herpes of six months' duration, with a large descemetocele and severe iritis. (c) Case 9-37. Lamellar graft of seven mm. to the depth of Descemet's membrane 10 days after operation. The iritis improved dramatically 48 hours after transplantation. (d) Case 9-37. A faint opacity remains beneath the clear lamellar graft. Vision is 20/200. The eye has remained quiet for one year. (e) Case 9-37. A penetrating graft replaces the lamellar graft in (d). Vision with correction is 20/30.

covered that contrary to instructions the patient had continued the use of topical steroid therapy two to three times daily during the entire two years!

An eight-mm. penetrating transplant was performed including the entire lamellar graft and the descemetocele. The postoperative course was uncomplicated and visual acuity one year later was 20/40 with correction.

CASE 15

Miss J. B., aged 16 years had had a dendritic keratitis of the right eye at the age of 18 months and probably also of the left eye, although the parents were not aware of it. Fine opacities of the left cornea were noted by an ophthalmologist at the age of eight years. At 11 years, there was a severe disciform keratitis of the left eye which reduced the vision to 5/200. The vision of the right eye was 20/200.

Penetrating keratoplasty was performed in the left eye using a seven-mm. disc with 12 direct sutures. The graft remained perfectly transparent and the visual acuity was 20/25. Twenty months after operation the patient complained of irritation of the eye and a slight blurring of vision. Three small dendrites were noted in the recipient rim of cornea superiorly. Adjacent to these, there were two small dendritic ulcers in the graft itself. These were controlled by cauterization with tincture of iodine and removal of the adjacent epithelium. No corticosteroids had been used during the year and a half preceding the appearance of these lesions.

Following cauterization and healing of the dendritic ulcers a series of small faint nummular le-

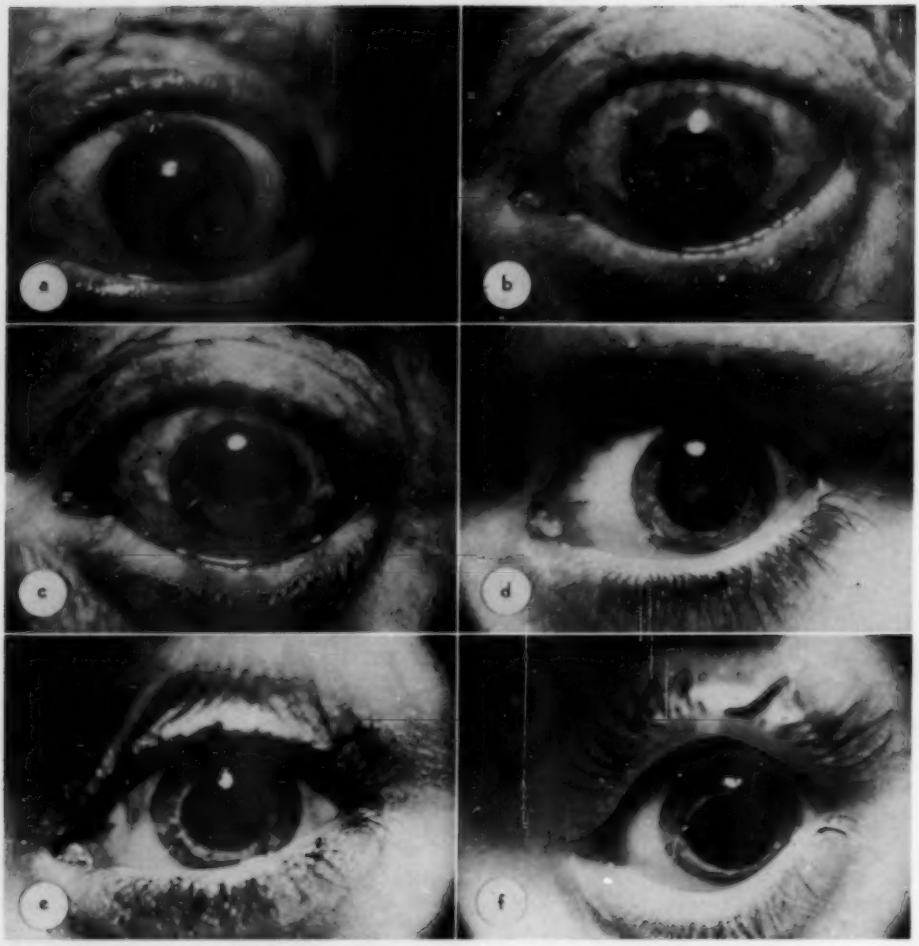

Fig. 3 (Fine). (a) Case 14, Group I. Bilateral metaherpetic keratitis. Recurrent superficial ulceration over 14 years. Immature cataract. Vision, 20/800. (b) Case 14, Group I. Clear penetrating graft seven mm. in diameter. The cataract has progressed. (c) Case 14, Group I. Cataract extraction with iridectomy performed six months after keratoplasty. Corrected vision, 20/40. (d) Case 15, Group I. Opacity from disciform keratitis at the age of two years. There is a faint opacity of the periphery of the cornea above. Patient is aged 16 years and both eyes are involved. (e) Case 15, Group I. Transparent graft one year after keratoplasty. Vision, 20/25. (f) Case 15, Group I. A dendritic ulcer appeared in the recipient cornea superiorly 20 months after keratoplasty and has spread into the graft. Vision after healing is 20/30.

sions appeared at the subepithelium level and involving Bowman's membrane. These have left faint opacities but vision is still 20/25.

2. Prolonged cases

Cases of prolonged recurrent superficial keratitis with ulceration (metaherpetic keratitis) and chronic anterior stromal keratitis: These are the most common and the most suitable cases of herpetic disease for therapeutic keratoplasty. These corneas usually present mild vascularization, often with only one or two large feeding vessels which can

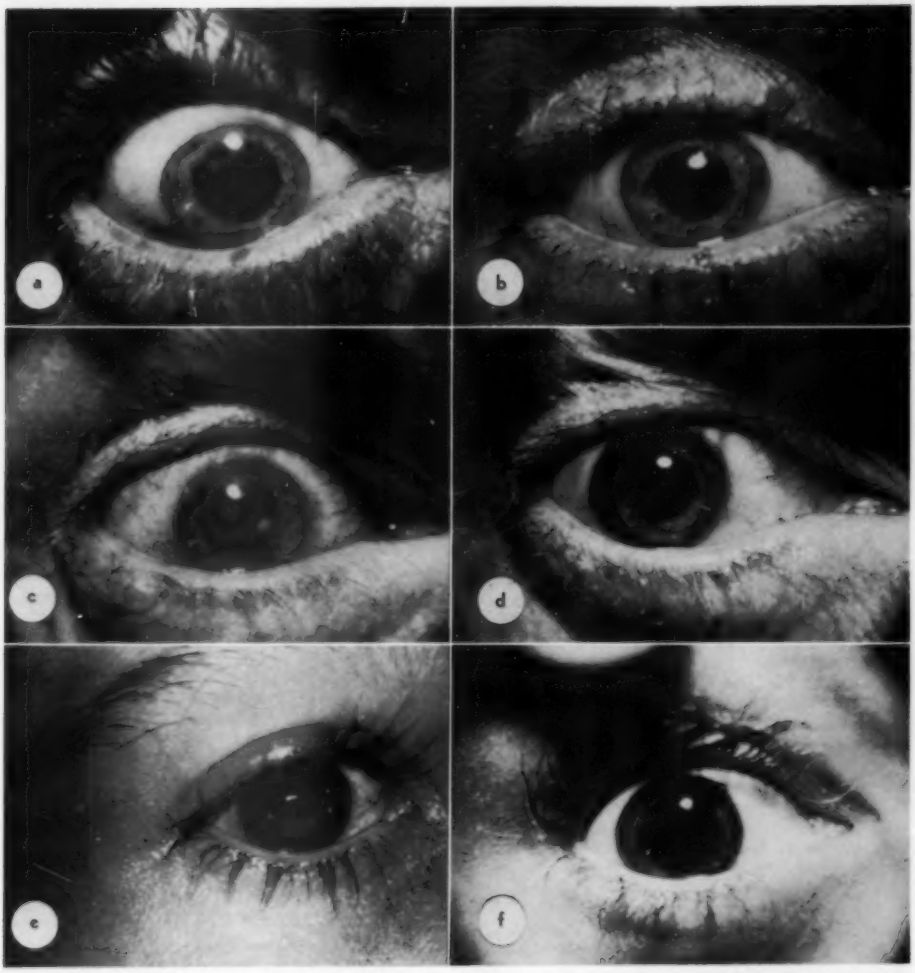

Fig. 4 (Fine). (a) Case 16, Group II. Recurrent superficial ulceration at intervals of two to four weeks. Small areas of deep keratitis. (b) Case 16, Group II. Transparent eight-mm. graft one year after operation. Vision, 20/25, corrected. No recurrence of keratitis. (c) Case 17, Group II. Recurrent superficial central ulceration, with deep infiltrates. Active two years. Patient has only one eye. (d) Case 17, Group II. Clear penetrating graft 13 months after keratoplasty. Vision, 20/25. (e) Case 18, Group II. Chronic superficial ulceration following herpetic keratitis at the age of one year. Patient is now aged nine years. (f) Case 18, Group II. Clear lamellar graft, eight mm. in diameter. The cornea is anesthetic and condensation chamber spectacles are worn for protection.

be coagulated at the time of the keratoplasty to minimize bleeding. In some the vascularity is limited to the peripheral cornea, the central portion of the cornea remaining avascular. This situation is encountered particularly in the cases of superficial recurrent ulceration (metaherpetic). The inflammatory signs in this group were for the most part mild, the patient appearing for treatment because of recurring episodes of irritation, pain, and moderate congestion. Although mild uveitis frequently accompanied these recurrences,

none of these patients had sufficiently severe iritis to produce visible synechias and the pupil could be dilated in all cases.

The 15 cases in this group have been summarized in Table 2. Within the period of observation there were three cases of recurrence of keratitis in the graft or adjacent to it (Cases 21, 23, and 25):

CASE 21

P. E., male, aged 47 years, had a dendritic keratitis in April, 1952. This was followed in about two weeks by a disciform keratitis which was treated with topical cortisone for a period of about six months. In February, 1954, a severe metaherpetic keratitis appeared with reduction of vision to 20/400. The cornea was reduced in thickness to about one half and there was repeated superficial ulceration.

In April, 1954, an eight-mm. lamellar transplant was performed without complication. Moderate vascularization of the graft bed appeared and was treated with beta irradiation. Six months after the transplantation the graft was fairly clear and vision could be corrected to 20/60. In March, 1956, the eye became irritable again and vision became reduced to 20/300. A large shallow crescentic ulcer formed at the temporal and inferior margins of the lamellar graft, involving the temporal one third of the graft itself. The stroma at the base of the ulcer appeared to be lost down to Descemet's membrane. There were only mild inflammatory signs.

An eight-mm. penetrating keratoplasty was performed to remove the area of ulceration and the greater part of the infiltrated lamellar graft. The transplant was placed slightly eccentrically to the temporal side to achieve this. On the fifth day after operation the anterior chamber which had been deep became very shallow. Serious attempts were made to find a leak in the wound but none was discovered. Air was injected into the anterior chamber after a posterior sclerotomy and drainage of fluid and additional sutures were placed at the nasal border of the graft where there was a suspicion of a slight malposition. The air was absorbed within 48 hours and the anterior chamber remained shallow. The intraocular pressure has remained soft to date and a complicated cataract has appeared. The cause of the hypotony in this patient has not been determined.

CASE 23

L. M., male, aged 50 years, had had a severe recurrent superficial, diffuse, herpetic keratitis for a period of about six months. This was followed by the appearance of spotty infiltration of the anterior and middle stroma, with heavy vascularization. Cultures from the conjunctiva and epithelium of the cornea were negative for bacteria and fungi. A moderately severe uveitis ensued which did not respond to therapy with corticosteroids and antibiotics. The chronic keratitis also continued unchanged.

In May, 1956, a 7.5-mm. penetrating transplant was performed. There was delay in reformation of the anterior chamber and an iris adhesion occurred at the lower border. This was separated about four weeks later. The eye became comfortable and the patient did well for a period of four months. In September, 1956, a superficial ulcer appeared on the graft followed by a rapidly developing infiltration of the stroma. There was a transient rise in the intraocular pressure which was controlled with miotics. The eye became markedly congested and painful with the recurrence of the keratitis. Because of the severity of the inflammation it was felt that a carefully supervised trial of treatment with prednisolone was justified. The eye became much quieter under this therapy, the congestion and vascularity were greatly improved, and the iritis subsided.

It was decided to perform a lamellar graft eight mm. in diameter to the depth of Descemet's membrane (Case 36). The dissection was begun in preparation for this but on reaching the central portion of the cornea it was found that even the deepest layers of the stroma and Descemet's membrane were necrotic, and that a large perforation would be produced. The operation was therefore changed to a penetrating one and was completed without complication. The pupillary border was found to be firmly bound to the lens and a thin inflammatory membrane was present. A small iridectomy was performed, which also resulted in pulling away a greater part of the membrane. There was an early complicated cataract.

The postoperative course was remarkably smooth, with minimal reaction. The graft remained perfectly transparent for a period of five weeks and then developed a mild edema without infiltration or ulceration. This has persisted for a period of five months and is believed to represent a mild immune reaction in the transplant. The eye has remained free of discomfort or congestion and the graft is avascular and only very slightly hazy.

CASE 25

C. S., male, aged 68 years, was seen at the Veterans' Administration Hospital, San Francisco, in January, 1957, with a complaint of recurrent pain in the left eye over a period of 20 years. There was a history of a minor injury with a piece of steel preceding the initial attack. The visual acuity of the eye had been poor for at least eight years. The right eye was normal except for moderate nuclear sclerosis of the lens. The left eye showed a very dense central disciform opacity about six mm. in size overlying the pupil. The cornea in this area was about one half normal thickness. There was chronic ulceration of that surface, the ulcer being about four mm. in size, irregular in outline, and with a moderately dense network of vessels entering from all directions. Corneal sensitivity was very poor.

Because the ulcer failed to heal over a period of more than a month and the patient suffered from severe pain and photophobia, it was decided to

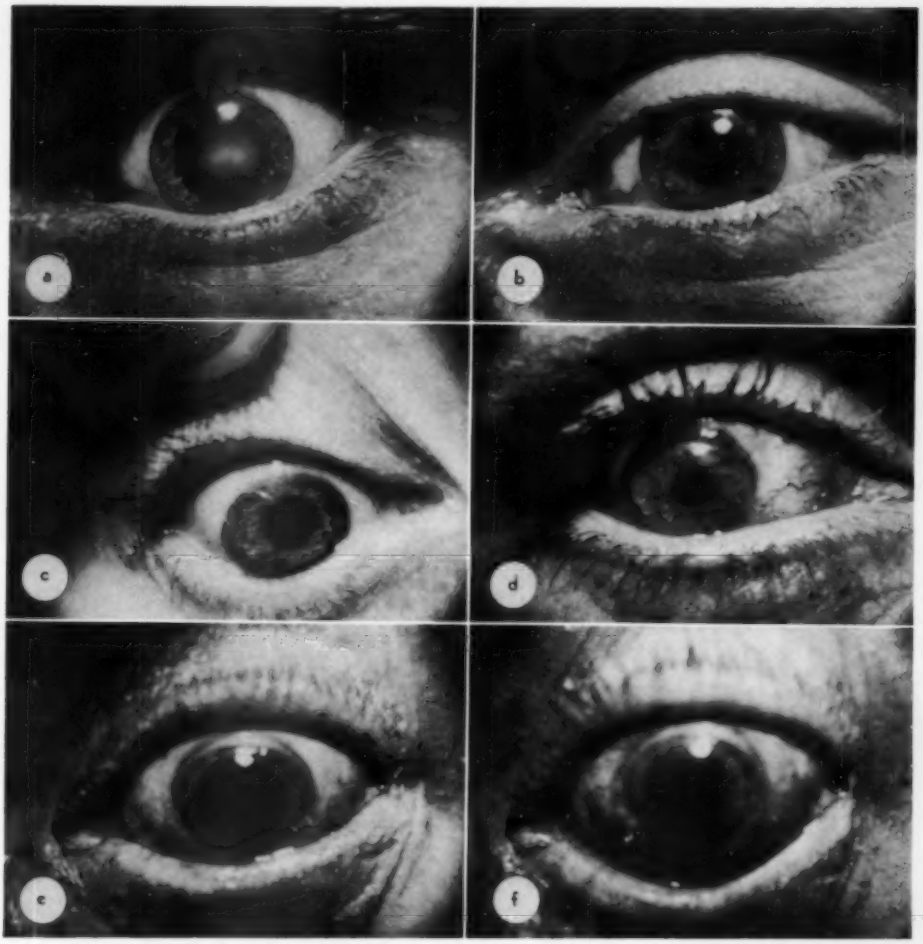

Fig. 5 (Fine). (a) Case 20, Group II. Disciform keratitis with recurrent superficial ulceration over four years. Vision, 1/200. (b) Case 20, Group II. Clear penetrating graft, eight mm. in diameter. Corrected vision, 20/25. No recurrence of keratitis. (c) Case 19, Group II. Eccentric penetrating graft replacing a small area of chronic herpetic keratitis. The graft is five mm. in size. Vision remained 20/30. (d) Case 21, Group II. Recurrence of crescentic area of ulceration at temporal border of lamellar graft. The stroma of the graft is involved as well as the recipient tissue. (e) Case 23, Group II. A penetrating graft has been performed to replace a previous graft in which there was a recurrence of a chronic stromal herpes. The entire cornea was involved. (f) Case 23, Group II. The second graft also suffers a recurrence of the herpetic keratitis after two months. Infiltration first appeared at the superior nasal quadrant where a margin of diseased tissue remained.

resort to keratoplasty. A seven-mm. penetrating transplant was performed without complication under general anesthesia. The patient vomited violently following the operation and on the following day a small iris prolapse was observed at the 2-o'clock position. The prolapse was replaced and the wound resutured.

The subsequent course was uncomplicated and the graft appeared clear until about three weeks later. At that time, following removal of the corneal sutures, it was noted that there was poor union of the graft at the nasal side, with a slight infiltration of the border. This area corresponded to a portion of the recipient cornea in which a narrow margin of the original disciform opacity remained. Infiltration of the stroma of the graft

TABLE 2

KERATOPLASTY IN CASES OF RECURRENT OR CHRONIC SUPERFICIAL HERPETIC KERATITIS: GROUP II

Case No.	Patient, Age, Hosp. No.	Indication for Keratoplasty	Duration of Disease	Type of Operation	Complications	Vision and Refraction		Period of Observation	Remarks
						Preoperative	Postoperative		
16.	E.C., 42 SUH #134288	Recurrent disciform ulceration; small areas of stromal keratitis adjacent. Recurrences at intervals 2–4 weeks	3 yr.	Penetrating 8 mm.	None	20/200	20/25 (−4.00×5)	14 mo.	No recurrence since operation
17.	T.S., 44 SUH 135645	Recurrent central ulceration with adjacent superficial stromal infiltrates. Vascularity ++ Other eye blind	2 yr.	Penetrating 7 mm.	None	5/200	20/25+2 (−2.00−2.00×165)	13 mo.	Very slight reactivation of keratitis outside of graft, 10 mos. after operation. Subsided in 3 days on topical prednisolone
18.	K.D., 9 LAH 4424-003	Chronic central disciform ulceration involving superficial stroma. Marked corneal anesthesia	8 yr.	Lamellar 8 mm.	Epithelial erosions due to exposure; controlled by use of condensation chamber and Methocel drops	Amblyopia exanopsia		1 yr.	Graft transparent. No recurrence of ulceration
19.	E.D., 36 MZH 117727	Recurrent superficial keratitis in upper temporal quadrant. Visual zone clear. Six recurrences in 3 years. Avascular	3.5 yr.	Penetrating 5 mm. (eccentric)	None	20/25 (+4.00+1.50×125)	20/30 (+3.50+1.50×40)		Graft transparent. Fine line of union is situated just at temporal border of pupil. No recurrence
20.	F.R., 18 MZH 116887	Recurrent superficial central disciform ulcer, moderately vascular. Diffuse nebula around central leucoma, recurrences in 4 years	4.5 yr.	Penetrating 8 mm.	None	1/200	20/25 (+3.00+2.00×115)	1 yr.	Graft transparent. No recurrence
21.	P.E., 47 SUH 132808	Metaherpetic keratitis—2 years. Frequent recurrences of ulceration cornea ¼ normal thickness	5 yr.	Lamellar 8 mm.	Moderate vascularization of graft. Treated with Beta Rays	20/400	20/60 (+3.25+5.00×25)	18 mo.	Large shallow superficial ulcer. Recurred at temporal margin of graft. Loss of substance to Descemet's Membrane. Temporal ¼ graft involved
22.	P.E., 47 SUH 132808	Recurrent ulceration at corner of graft in case 21. 7 complication of steroid therapy	9 mo.	Penetrating 8 mm.	Poor union of graft at nasal margin of graft which was 1 mm. inside border of previous lamellar graft	20/200	H.M.	5 mo.	Graft resutured. Anterior chamber remained shallow and could not be restored by posterior sclerotomy, drainage of suprachoroidal fluid and air injection into anterior chamber. Eye has remained soft and complicated cataract has developed. Light projection good

Case No.	Patient Age, Hosp. No.	Indication for Keratoplasty	Duration of Disease	Type of Operation	Complications	Vision and Refraction Preoperative	Vision and Refraction Postoperative	Period of Observation	Remarks
23.	L.M., 50 SUH E132394	Recurrent superficial ulceration with stromal infiltration involving entire cornea. Many deep vessels	2 yr.	Penetrating 8 mm.	Iris adhesion freed 4 weeks after transplantation	20/200	20/400	5 mo.	Recurrence of keratitis in recipient cornea and in graft 5 mos. after operation. Central necrosis and ulceration
24.	W.D., 38 VAH 69960	Metaherpetic keratitis, marked thinning of stroma. Recurrent ulceration. Few vessels	3 yr.	Penetrating 8 mm.	None	20/400	20/20 (+2.50+2.00×80)	3 yr.	No recurrence. Graft clear
25.	C.S., 68 VAH 94300	Recurrent superficial keratitis and scattered stromal keratitis. Moderate vascularization. Center of cornea very thin	20 yr.	Penetrating 7 mm.	Iris incarceration at 1 o'clock position, second day after operation, iris replaced and wound resutured	Finger Counting 1 ft.	Finger Counting 1 ft.	4 mo.	Small area of infiltration and slight necrosis in graft at nasal side, adjacent to area of infiltration not included in trepanation.
26.	C.S., 68 VAH 94300	Recurrence of keratitis in penetrating graft, adjacent to area of residual keratitis in recipient, case 25	4 mo.	Lamellar 8 mm. overlapping margins of previous penetrating graft	None	Finger counting 1 ft.	Finger counting 2 ft.	4 mo.	Graft transparent. No recurrence. Slight vascularity of graft bed. Vessels now devoid of blood. Arteriosclerotic macular changes
27.	J.M., 21 VAH 73160	Disciform keratitis with marked thinning of cornea and central crater. Recurrent ulceration 3 yrs.	7 yr.	Penetrating 7 mm.	None	20/300	20/20 (−6.00 sph)	3 yr.	Clear graft. No recurrence
28.	A.G. VAH 95,280	Severe metaherpetic keratitis. Disseminated stromal infiltrates. Heavy vascularization	8 yr.	Penetrating 8 mm.	None	H.M.	20/70 (−3.00+1.75×90)	6 mo.	Graft clear. Eye quiet
29.	R.S., 21 LAH 4313-029	Disciform keratitis. Recurrent activity 2 yrs. Marked vascularity	2 yr.	Penetrating 8 mm.	Late edema of transplant with bullous keratopathy	20/400	20/400	6 mo.	Reoperation after 6 mos. Corneal graft remained edematous with bullae. No vessels except around line of union
30.	R.S., 21 LAH 4313-029	Late edema and bullous keratopathy of graft, case 29. Infiltration and vascularisation upper border	6 mo.	Penetrating 8 mm.	Moderate postoperative uveitis	20/400	20/46	1 yr.	Graft clear. No activity

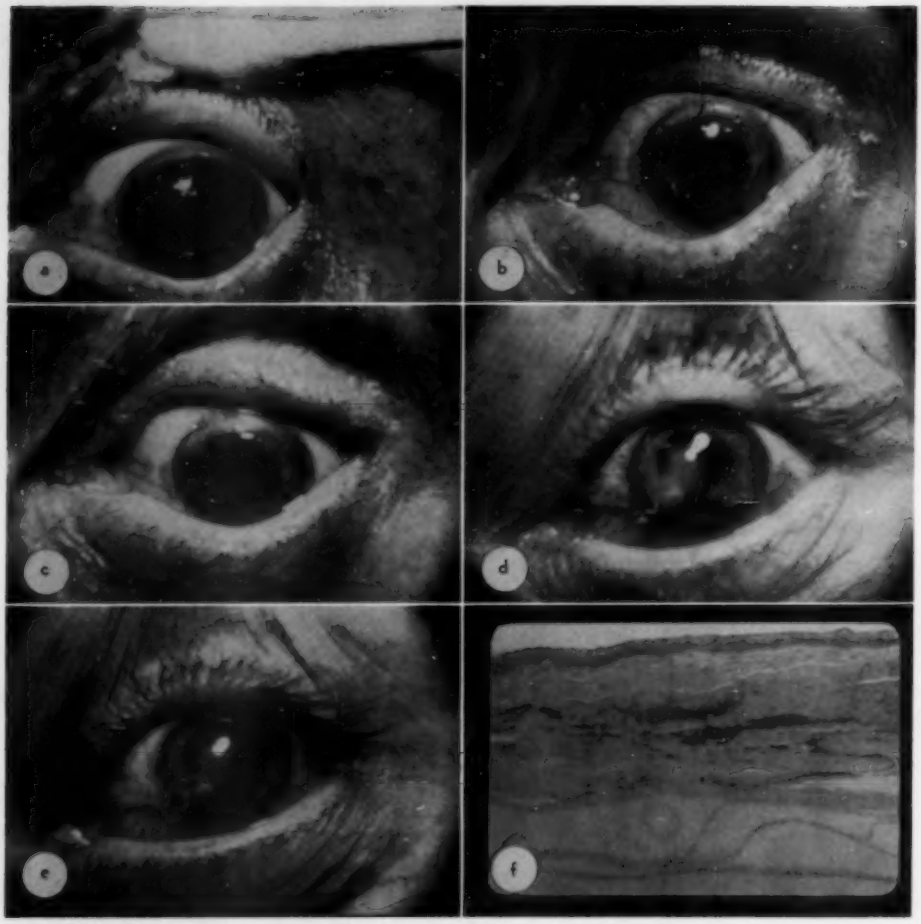

Fig. 6 (Fine). (a) Case 25, Group II. Recurrence of keratitis in a seven-mm. penetrating graft. The infiltration began at the nasal border and spread centrally. The deeper stroma remained clear. (b) Case 25, Group II. An eight-mm. lamellar graft has been used to replace the outer half of the penetrating graft, four months after the first transplantation. (c) Case 25, Group II. The transparent combined penetrating and lamellar graft shows how an additional mm. of recipient cornea was removed at the nasal side. (d) Case 31, Group III. Chronic severe stromal herpes of 11 years' duration. Heavy vascularization of the superficial and deep stroma. (e) Case 31, Group III. Marked improvement in vascularization and infiltration following two weeks of topical cortisone prior to keratoplasty. All the diseased stroma could not be removed and the keratitis recurred in the graft, beginning at the nasal side. (f) Case 31, Group III. Penetrating corneal button removed at operation. There is a heavy cellular infiltration of the middle and deep stroma and marked disorganization of the lamellae. Bowman's membrane is lacking in many areas.

continued to spread from this area, principally in in the superficial layers. It should be pointed out that this infiltration on the nasal side was not related to the iris prolapse which had occurred on the temporal side.

Three months after the penetrating transplant there was no improvement in the appearance of the graft, and since the deeper stroma appeared clear it was determined to perform a slightly larger lamellar graft to replace the involved stroma and at the same time reinforce the weak line of union. An eight-mm. lamellar transplant was done without difficulty. There was immediate improvement in symptoms and the graft united well, and has re-

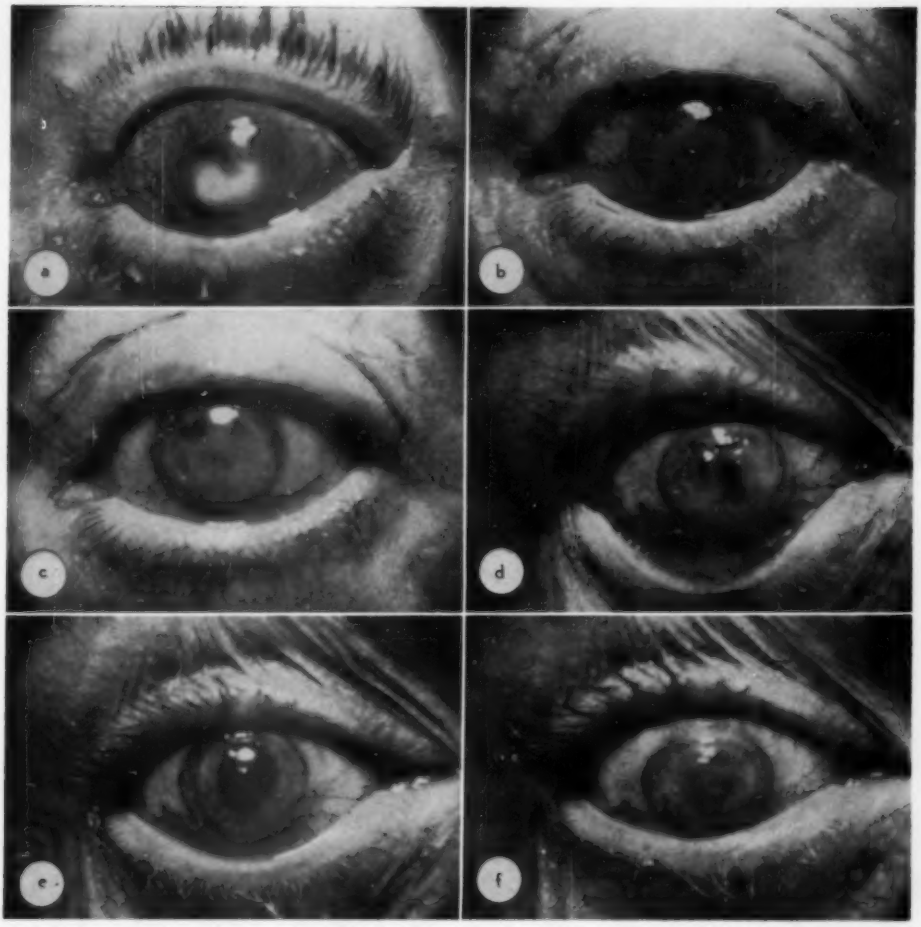

Fig. 7 (Fine). (a) Case 34, Group III. Severe chronic stromal keratitis with necrosis and early descemetocele. There is a severe iritis and a complicated cataract. Duration, five months. (b) Case 34, Group III. A lamellar graft was prepared to the depth of Descemet's membrane. The Descemet's membrane of the recipient was found to be necrotic and the central four mm. were removed. The round perforation may be seen through the lamellar graft. (c) Case 34, Group III. The central portion of the lamellar graft has become cloudy but the eye is now quiet and comfortable. The patient died of bronchogenic carcinoma one year later. (d) Case 35, Group III. Recurrent deep keratitis with necrosis and descemetocele. The present episode was of three months' duration. Moderate iritis. The entire cornea was involved. (e) Case 35, Group III. An eight-mm. graft was done to the depth of Descemet's membrane. The site of the descemetocele may be seen through the transparent graft. (f) Case 35, Group III. The temporal and nasal border of the graft has suffered a recurrence of the keratitis, with ulceration. A retransplantation is to be performed.

mained clear to the present time. The fundus can be seen well, and shows senile macular changes which reduce the vision to finger counting. The corneal vascularity has regressed markedly. The patient has been free of symptoms.

3. Cases of severe chronic stromal keratitis with necrosis

This severe form of herpetic keratitis was quite unusual prior to the past decade. It is

TABLE 3

KERATOPLASTY IN CASES OF CHRONIC STROMAL HERPETIC KERATITIS WITH NECROSIS: GROUP III

Case No.	Patient, Age, Hosp. No.	Indication for Keratoplasty	Duration of Disease	Type of Operation	Complications	Vision and Refraction Preoperative	Vision and Refraction Postperative	Period of Observation	Remarks
31.	R.H., 28 SUH 90,901	Chronic stromal keratitis, extending to limbus at nasal side. Heavy vascularization. Recurrent ulceration for 10 yrs.	11 yr.	Penetrating 6.5 mm. (eccentric)	Moderate vascularization of graft, controlled by Beta Rays	20/800	20/200	2 yr.	Recurrence of stromal keratitis in graft at nasal border. Mild edema. Graft nebulous
32.	F.Z., 55 SUH E130856	Recurrent herpetic stromal keratitis in penetrating corneal graft 7 mm., intumescent cataract, iris adhesions, secondary glaucoma	16 mo.	Penetrating 8 mm. and cataract extraction	Expulsive choroidal hemorrhage	H.M.	Nil		Evisceration of globe
33.	J.L., 63 SUH E131539	Recurrent deep keratitis with necrosis and perforation at border of lamellar graft, Case 8	2 yr.	Penetrating 8 mm.	None	20/400	20/40 (+3.00 sph)	18 mo.	Graft clear. No recurrence
34.	H.K., 63 SUH 134889	Severe stromal keratitis with necrosis, uveitis and two Descemetoceles. Active for 5 mos. Complicated cataract	5 mo.	Lamellar 8 mm. To level of Descemets	Moderate postoperative reaction	H.M.	H.M.	1 yr.	Graft slightly nebulous and vessels below graft. Eye has been free of inflammation. Patient discovered to have carcinoma of lung with metastases
35.	E.J., 55 SUH 139455	Recurrent ulceration and deep keratitis 3 mos. Necrosis and Descemetocele 1 week. Entire cornea involved. Recurrence over 30 years	3 mo.	Lamellar 8 mm.	Poor union of graft at temporal and nasal side. Graft moderately edematous at 3 weeks	Finger counting 6 inches	20/800	6 mo.	Recurrence of keratitis in graft with edema and infiltration 3 weeks after transplantation. To have retransplantation
36.	L.M., 50 SUH E132394	Recurrence of deep keratitis with necrosis in penetrating graft, case 23. Chronic inflammation, secondary glaucoma. Many vessels	5 mo.	Penetrating 8 mm. Iridectomy Removal of inflammatory papillary membrane	Lamellar graft had been planned. Cornea was found through Descemets and operation was changed to penetrating	Finger counting 1 ft.	Finger counting 1 ft.	6 mo.	Graft very slightly edematous, avascular. No inflammation. Tension normal. Patient comfortable
37.	E.H.P., 27 SUH E129797	Chronic disciform keratitis with necrosis. 4 mm. Descemetocele. Moderate vascularization. Mild recurrences over 9 years, bilateral	3 mo.	Lamellar 7 mm.	Vessels between graft and Descemets. Moderate infiltration below graft	20/400	20/200	14 mo.	Opacity under lamellar graft. No recurrence of keratitis. Eye completely quiet. Area of lamellar graft to be replaced by penetrating graft (see case 9)
38.	J.R., 61 VAH 74,663	Chronic keratitis with necrosis and Descemetocele. Severe uveitis. Heavy vascularization of peripheral cornea	3 yr.	Penetrating 8 mm.	Mild edema of graft at 1 month. Subsided with faint residual haze	L.P.	20/200	2.5 yr.	Marked improvement in uveitis immediately after transplantation. Eye has remained quiet without recurrence of keratitis. Graft avascular, slightly nebulous

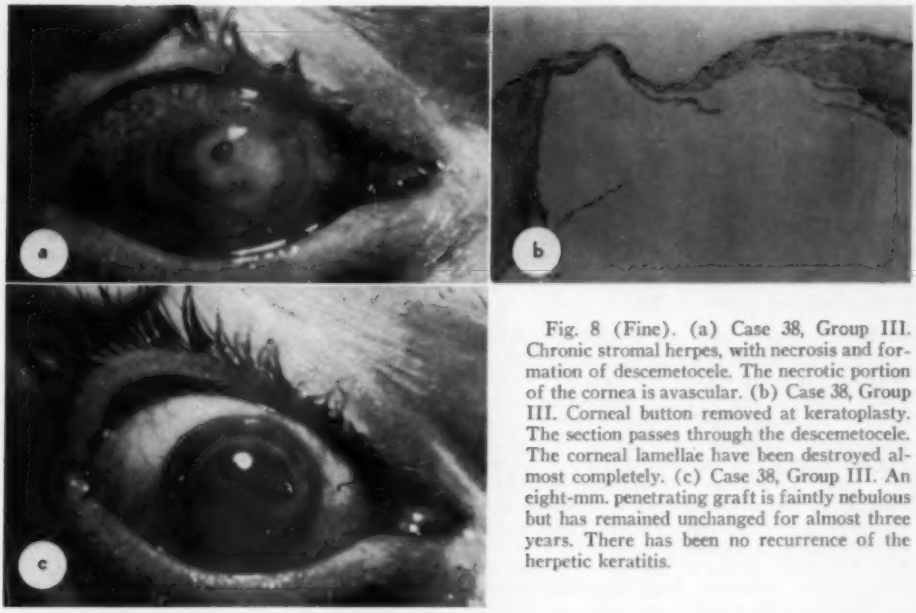

Fig. 8 (Fine). (a) Case 38, Group III. Chronic stromal herpes, with necrosis and formation of descemetocele. The necrotic portion of the cornea is avascular. (b) Case 38, Group III. Corneal button removed at keratoplasty. The section passes through the descemetocele. The corneal lamellae have been destroyed almost completely. (c) Case 38, Group III. An eight-mm. penetrating graft is faintly nebulous but has remained unchanged for almost three years. There has been no recurrence of the herpetic keratitis.

now quite commonly seen and Thygeson has pointed out the possible relationship between the introduction of cortisone therapy and the change in the nature of disciform keratitis from a relatively benign disease to a rapidly progressing necrotizing lesion. The necrosis of the stroma may extend through Descemet's itself producing a perforation (Cases 33 and 36). More frequently the resistant internal elastic membrane remains intact for a longer period and one or more descemetoceles may appear (Cases 34, 35, 37 and 38). Severe uveitis is a frequent complication of these deep forms of the disease, and hypopyon may occur. Vascularization is usually intense at the periphery of the cornea but the central portion in which the necrosis of the stroma occurs usually remains avascular. Because of the necrosis and the sloughing of the overlying epithelium, as well as the absence of blood vessels, secondary infection is common. In this group of cases the removal of the necrotic corneal tissue by transplantation of cornea appears to influence the course of the disease very promptly and very favorably. Even in those cases in which the transplant has not remained completely clear the congestion of the globe has improved dramatically, often within a few days after surgery, and the uveitis has subsided.

Of the eight operations in this group, one eye was lost from an expulsive choroidal hemorrhage at the time of surgery. In two cases there has been a mild recurrence of keratitis in the corneal graft but the general state of the eye may be considered definitely improved by the keratoplasty:

CASE 31

R. H., female, aged 28 years, was seen in January, 1951. She had had recurrent episodes of keratitis with superficial ulceration over a period of 11 years. Vision was reduced to 20/800. During the preceding year there had been almost constant irritation and discomfort. In 1950, she had received X-ray therapy over a period of two months in an attempt to obliterate the vascularity of the cornea. The left cornea showed a very dense central disciform opacity in the middle and deep stroma, with an area of necrosis at the nasal margin. Overlying the disciform lesion was a layer of chronically edematous cornea with loss of the epithelium. This edematous ulcerative lesion extended to the limbus on the nasal side. Many large vessels extended from this site into the central portion.

In an effort to remove the necrotic portion of the cornea a 6.5-mm. square, eccentric, penetrating corneal graft was performed in April, 1951. The nasal border of the graft unavoidably lay within involved tissue. The postoperative course was uncomplicated except for the appearance of a few fine vessels across the line of union at the nasal side. These regressed promptly after treatment with the Strontium[90] applicator. The nasal margin of the graft, in contact with the infiltrated remnant of the recipient cornea, became slightly infiltrated and edematous. Two years later only a very slight edema remained in this area. The eye has been entirely comfortable and only a slight limbal flush was present at the nasal side.

Case 35

E. J., male, aged 55 years, had had a dendritic ulcer of the right eye at the age of 25 years. Vision remained somewhat impaired but no further medical treatment was necessary until January, 1956. At this time a severe disciform keratitis associated with severe uveitis and considerable pain took place. Stromal necrosis appeared within two months, in the absence of any treatment with corticosteroids. After four months a descemetocele formed and the globe was threatened with perforation. The entire cornea at this time was gray and gelatinous in appearance. There was moderate vascularization of the stroma and a moderate iritis.

In the presence of an active iritis and threatened perforation it was decided to perform an eight-mm. lamellar graft to the level of Descemet's membrane. The operation was completed without perforation of the descemetocele and the immediate postoperative result was excellent. There was marked improvement of the iritis and the bulbar congestion within 48 hours after operation. The graft remained clear except for a ringlike opacity at the site of the descemetocele, underneath the transplant. At the end of two weeks the transplant became slightly hazy and edematous and a few small bullae appeared in the epithelium. A few days afterward a shallow dehiscence appeared at the peripheral border of the graft, where union had seemed good. This dehiscence increased to a width of about two mm., suggesting that there had been a loss of substance in the area. The eye has remained uncongested during these changes. It is suspected that these may represent trophic changes in the presence of corneal anesthesia but it is possible that a low-grade keratitis on a herpetic basis has recurred in the graft.

Summary and Discussion

The results in this group of 38 operations confirms the view of earlier authors that corneal transplantation offers the only effective means of treatment in cases of recurrent or chronic herpetic keratitis. Even in the presence of active uveitis the operation seems to be relatively safe if proper choice of technique is made. In the 31 eyes in this series one eye was lost from an expulsive choroidal hemorrhage. This was an extremely complicated operation in which it was attempted to remove an intumescent cataract through a penetrating trephine opening at the time of the keratoplasty. In all the other patients but two there was clinical improvement following corneal transplantation, despite the fact that there was a recurrence of the keratitis in eight of 38 operations. It is noteworthy that these recurrences were relatively mild as compared with the pre-existing keratitis, at least within the period of observation. There was no instance in which the keratitis or the uveitis was aggravated by the surgical procedure. Particularly striking is the marked improvement in the inflammatory signs following keratoplasty, either lamellar or penetrating, in the patients with deep keratitis and stromal necrosis. This amelioration appeared so promptly and so regularly after surgery, within 24 to 48 hours, that there could be question of its being the result of the surgery.

The technical question of the choice between lamellar and penetrating grafts in these cases cannot be answered categorically from the results in this limited number of cases. The impression gained may be summarized as follows, although further observations may modify some of these views:

1. In cases of quiescent herpetic opacities, either diffuse or circumscribed, pentrating keratoplasty offers the best opportunity for visual improvement with very little difference in the operative risk. Even in opacities limited to the superficial stroma I shall continue to prefer penetrating grafts since these belong in the favorable group of indications for optical keratoplasty.

2. In cases of diffuse superficial ulceration with or without scattered areas of stromal infiltration, lamellar keratoplasty appears to be preferable to penetrating. The graft, unless it is total, must have its borders in diseased tissue and under these conditions it seems advantageous to have an underlying

bed of healthy stroma to support the graft. Such cases exhibited poor union of the graft edges and therefore an increased hazard for penetrating keratoplasty. If the visual result from such a lamellar graft is inadequate a penetrating graft may be performed at a later date as in Case 9. In cases of circumscribed superficial ulceration a penetrating transplant, if it can encompass the entire visible lesion, is more certain to give an adequate visual result.

3. In the severe cases of deep keratitis with necrosis, often complicated by a severe uveitis and a descemetocele, a lamellar graft is undoubtedly the safer procedure where it is suitable. Where there is heavy vascularization of the cornea a lamellar graft will practically always develop a dense vascularity beneath the graft, particularly if the necrosis has involved the deep stroma. In such cases, although the prognosis for vision is poor in both, a penetrating graft appears to offer better chance of improvement. The vessels cut across at the time of operation are frequently limited by the line of union and may surround the graft without entering it. If a lamellar graft is placed in the same type of vascularized cornea the vessels will continue across the line of union and spread beneath the graft.

If necrosis has advanced to the point of producing a descemetocele a lamellar graft to the level of Descemet's membrane seems to be the technique of choice. Accurate trephining of such eyes with a descemetocele is usually difficult and the keratitis in these eyes is usually widespread so that the borders of even a large graft will lie in diseased tissue. On the other hand the necrosis may be so deep that even Descemet's membrane is involved and an attempted lamellar graft will result in a large ragged perforation. In such a case it seems preferable to use a cleanly cut penetrating graft rather than risk such a ragged perforation through which the stroma of a lamellar graft is exposed to the aqueous.

When a severe uveitis is present, with a congested iris, there is increased hazard of hemorrhage from the iris, ciliary body, or choroid when the eye is opened. These cases therefore are handled more safely through a lamellar graft.

Where perforation has already occurred and the globe is soft it is technically easier to perform a penetrating transplantation. Clean dissection of a lamellar graft in such cases is almost impossible. If the perforation is of any size and a lamellar graft is placed over it the exposed stroma will become swollen from contact with the aqueous and usually will remain edematous.

Conclusions

At the present time corneal transplantation offers the only definitive means of controlling or terminating a recurrent or chronic herpetic keratitis. In 38 operations for various forms of corneal herpes, 15 in quiescent cases and 23 in cases of active keratitis, all but three showed clinical improvement.

Recurrence of the keratitis in the graft is particularly apt to occur if the visible lesion is not or cannot be excised completely and a portion of the graft border lies in contact with diseased tissue. The recurrence always appeared first at this site and in four of the eight cases, recurrence remained limited to a small area adjacent to the site. Clinical improvement may be effected even in the presence of a recurrence in the graft if no other complications appear. In one favorable case of optical keratoplasty in a healed disciform keratitis the recurrence was in the form of a dendritic ulcer, arising first in the recipient cornea and spreading into the graft. In the other seven the recurrence appeared as an infiltration and vascularization of the stroma near the line of union.

The mode of action of corneal transplantation in improving herpetic keratitis is not clear but several possibilities have been suggested. At least in chronic stromal herpes the removal of diseased and necrotic tissue appears to be a very important factor.

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References

1. Thygeson, P.: Herpes corneae. Am. J. Ophth., **36**:269, 1953.
2. Thygeson, P., Kimura, S. J., and Hogan, M. J.: Observations on herpetic keratitis and keratoconjunctivitis. Arch. Ophth., **56**:375, 1957.
3. Ormsby, H. L.: Superficial forms of herpetic keratitis. Am. J. Ophth., **43**:107 (Apr., Pt. II) 1957.
4. Rake, G. W.: The etiologic role of the virus of herpes simplex in ophthalmic disease. Am. J. Ophth., **43**:113 (Apr., Pt. II) 1957.
5. Paufique, L.: The therapeutic lamellar graft. Tr. Ophth. Soc. U. Kingdom, **69**:67, 1949.
6. Franceschetti, A., and Doret, M.: Keratoplastie à chaud. Ophthalmologica, **120**:11, 1950.
7. Gallenga, R.: On partial lamellar keratoplasty. Ross Ital. Ottal., **19**:3, 1950.
8. Foster, J.: A case of chronic dendritic ulceration treated by a lamellar corneal graft. Tr. Ophth. Soc. U. Kingdom, **70**:110, 1950.
9. Giani, P.: Late results of lamellar keratoplasty in metaherpetic keratitis. Ross. Ital. Ottal., **20**:382, 1951.
10. Hobbs, H. E.: Three therapeutic lamellar grafts. Brit. J. Ophth., **38**:61, 1954.
11. Paton, R. T.: Keratoplasty. New York, McGraw-Hill, New York, p. 76.
12. Hogan, M. J.: Corneal transplantation in the treatment of herpetic disease of the cornea. Am. J. Ophth., **43**:147 (Apr., Pt. II) 1957.

THE OPHTHALMIC RESEARCH INSTITUTE OF AUSTRALIA*

And its possible impact on ophthalmic surgery and medicine

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Hobart, Tasmania

Introduction

Three days ago I paid a visit to Capt. James Cook's Memorial on Hawaii. It was there on his third momentous voyage that he met his death. But before that he had opened up to Western civilization a panorama extending the whole length and breadth of the Pacific. May I remind you that on his first voyage, travelling on the *Endeavour* in great harmony with Sir Joseph Banks and Dr. Daniel Solander, he landed on the east coast of New Holland at a spot just a few miles from the present great metropolis of Sydney (Hawkesworth, 1773).

In the National Library at Canberra is the *Journal* of Capt. James Cook, and if you open it at his entry of Sunday, 6th May, 1770, you will see that in view of the many fine botanical specimens which Banks had collected, he, Cook, decided to rename Stingray Harbor and call it Botany Bay. He had already called its northern headland Cape Banks, and its southern headland Point Solander after his two great botanical research workers. Australia was born with an acute research flare which Sir Joseph Banks never let die during his 42 years as president of the Royal Society of Great Britain (Cameron, 1952) and this flare is still alive in Australia, although it is nearly 200 years since the naming of Botany Bay.

Ophthalmic Research Institute

The conception of an ophthalmologic society in Australia in 1937, followed by the inauguration of the Ophthalmic Research Institute of Australia in 1952, the donation of the "D. W. Funds" in 1955, and the opening of the Lions International Research Unit at the Victoria Eye and Ear Hospital in Melbourne in 1957, has welded ophthalmic thought in Australia into dynamic action. Besides this the publications of J. Lockhart Gibson (1922), Arthur H. Joyce (1949-1954), Sir Norman Gregg (1941 and 1944), Prof. Ida Mann (1954, 1955, 1956), J. Ringland Anderson (1931, 1939a, 1939b), K. Campbell (1951), and other Australians

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on ophthalmologic problems peculiar to the fifth continent have clearly brought our work to international attention.

The future

Brig. Gen. David Sarnoff recently said "The last 100 years have compassed more technical achievements than the millennium that preceded them, and the next half century will give us a technological progress unprecedented in volume and kind. There seems no doubt that whatever the mind of man can visualize, the genius of modern science can turn into fact. Medicine can look for incalculable aid from science and technology." In fact "new techniques can promise us fabulous days ahead." I feel we must keep these remarks clearly before us when planning for the future of ophthalmologic research whether it is in the first or fifth continent.

Research can take very many forms and as in the case of cortisone can lead along a path hardly to be anticipated. There is clinical research which often receives no report in print although proceeding consistently all the time. There is the therapeutic research which latterly has been so effectively explored by progressive drug houses. There is the radioactive research which may yet bring added relief to some forms of new growth, and perhaps to ophthalmology (Dunphy, E. B., 1956). Then there are the various researches going on in pathologic, biochemical, and bacteriologic laboratories—not forgetting the virologic laboratories—that often grudgingly bear unexpected fruit. The results are often unpredictable and sometimes epoch making, but as Alan Gregg once pointed out "No donor of funds to a single research project can honestly be promised a discovery. But if he will continue giving money to well chosen workers who have sensible leads, experience shows that sooner or later he will be rewarded." Well chosen workers with sensible leads will certainly be our endeavor in Australia. At the same time we must remember that it was not planned research which directed Newton to discover the laws of gravitation, or organized Faraday's discoveries in electricity, while Thomas Young's researches on optics were entirely original (Wood, 1954).

Youth

Benjamin Disraeli—the great Lord Beaconsfield—once said "The youth of a nation are the Trustees of Posterity." We must keep this also in mind when directing our research work and in appointing our workers. The medical student and the young interne often have original ideas which lack of time and money on their part prohibits them harvesting. Koller in his student days discovered cocaine which revolutionized ophthalmology and he cannot be an exception. There must be many young students capable of original work if given the right opportunities. The Ophthalmic Research Institute of Australia hopes to give these opportunities to youth.

A tribute

I feel this is a fitting juncture to offer my warmest tribute to the part which English-speaking countries have played, and intend to play, in the promotion of ophthalmologic research. It is my pleasure today to pay this tribute personally and to give you some idea of what Australia hopes to do in the future, or may I say more accurately what I hope Australia will do shortly in ophthalmologic research.

There are no chairs in ophthalmology in any of the medical schools of Australia either for undergraduate or postgraduate teaching. Now that both Sydney and Melbourne Universities are examining in a two-part postgraduate diploma in ophthalmology, this seems a fitting time when chairs at both universities could be established with advantage. For in Professor Bishop's Department of Physiology at Sydney University neuro-ophthalmologic research sponsored by the Ophthalmic Research Institute of Australia is well under way and in Melbourne

the new Lions International Research Unit is established in a university teaching hospital. Some orchestras can manage, but most are the better for a conductor, and the contemplated professorial unit in each university would be a most wise move.

Statistical surveys

There is in the continent of Australia, which extends from the antarctic almost to the equator, such a variety of climatic conditions and such a variety of local diseases that the field of research is almost limitless. Quite recently Prof. Ida Mann's epic surveys of the Kimberleys, Kalgoorlie, Goldfields, and the southeast of west Australia, together with New Britain and New Guinea (1954-1956) has proved to us conclusively the urgent need for virologic studies of trachoma in these areas. This is also being sponsored by the Ophthalmic Research Institute of Australia.

Basil Ward two years ago was doing a trachoma survey in Fiji, but his results have not yet been published, and may be interesting comparable data.

Some years ago Hamilton and Counsell (1937), and later J. B. Hamilton (1940), covered most of the statistical ground in Tasmania, both as regards blindness and eye diseases. Besides this, J. Ringland Anderson (1939a) covered the state of Victoria and Frank Flynn (1957) certain areas in the Commonwealth Northern Territory. But there are still vast areas to be surveyed and large city populations to be assessed. The pterygium map which Ringland Anderson (1954) presented to the International Congress in New York was an interesting piece of work and dramatically showed the influence of climate on one eye disease in our large continent. A map of virus keratitis might give incidences quite in the reverse direction. It is certainly our most troublesome problem in Tasmania in 1957, and we have no figures for either subtropical Brisbane or Adelaide to guide us.

Zoonoses

And this brings us to zoonoses on which I spoke at the 15th annual meeting of the ophthalmological Society of Australia at Canberra (1955). It is a field only partially explored and certainly by no means checked. Nothing occurs in Australia to be compared with the River Valley blindness of Nigeria; but with the white population increasing in tropical Queensland and New Guinea and the Northern Territory, zoonosis is a force to be watched more carefully. We must know more of the ocular complications of brucellosis, of toxoplasmosis, of scrub typhus, of leptospirosis, and the Q fever which are all potential causes of intraocular and intracranial inflammation, and more of their therapeutic response.

Fifteen years ago (1943) when a member of the second Australian Imperial Force, Middle East, I wrote a paper on ocular complications in relapsing fever and its complete lack of response to therapy. So far the disease has not appeared in Australia but will similar diseases already present in Australia respond to routine therapy? There are many gaps in our therapeutic knowledge which need filling in and the Ophthalmic Research Institute should be our guide star.

Uveitis

I fancy, myself, that one of the first steps in Australia should be an analysis of uveitis from Thursday Island to Tasmania. There are such a myriad of etiologic causes (Woods, A. C., 1956), from "sugar fever" to "abortus fever" and we must have factual diagnoses before we rely on empirical drugs (Alvaro, M. E., 1956).

We have glaucoma and diabetic clinics in Australia but we do need uveitus clinics where full investigation, followed by specific treatment, can be carried out. Although ocular toxoplasmosis has been clinically present in Tasmania since 1860, the first case was not reported until 1945. From investigations

in the United States it appears as if 25 percent of uveitis cases give a positive dye test for toxoplasmosis (Hogan, M. J., 1951; Kimura, 1954), yet we have no comparable Australian figures.

In Hobart medical and veterinary science have practically excluded syphilis, tuberculosis, and brucellosis from our midst. As a result uveitis is a declining disease but the etiology of the remaining cases is mostly shrouded in mystery and needs immediate clarification.

Glaucoma

Although both Sydney and Hobart have had glaucoma clinics for many years—yet the unwritten story of their progress is most disappointing. This disappointment is somewhat counteracted by the fact that the new Lions International Research Unit in Melbourne together with the Alfred Hospital will assist in the formation of a glaucoma research unit. Its plan of campaign has not been announced yet, but I would suggest a full therapeutic investigation into the response of normal and pathologic tension to Diamox, the tranquilizers (Paul and Leopold, 1956), and to the relaxants (Sysi, 1955) which might be fruitful, keeping in mind the increasing role which trauma, exfoliating lens capsule, iris atrophy, and uveal exudates play in the raising of intraocular pressure. This would give a new angle to glaucoma research and not clash with the many facets of this work being undertaken at the Ophthalmic Research Institute in London under Sir Stewart Duke-Elder's direction (1956).

Inherited eye diseases in pediatrics and geriatrics

In 1951, I published a preliminary survey in book form entitled, *The Significance of Heredity in Ophthalmology: A Tasmanian Survey*. So far there has been no corresponding work from the other five Australian states, but it should be encouraged in view of the published work from medical and veterinary schools on inherited eye diseases both in America and the United Kingdom (Smythe, R. H., 1956). Further, the vast influx of new Australians into the six Australian states is already producing new inherited problems and consequently widening the field of investigation in the genetic class. An institute of medical and veterinary genetics in Australia would be a great boon, similar to the one in Geneva founded by Franceschetti (Streiff and Babel, 1957). For as Burnet says we are facing two genetic problems in the next 50 years, one as the result of survival of the unfit, and the other from irradiation. It would therefore be a great advantage if Australia were able to make a genetic stocktaking before 1958. In other words have a pre- and post-"Christmas Island" survey.

Industrial ophthalmology

This is a completely untouched field in Australia—it is daily producing new and as yet unsolved problems. And in view of the Workers' Compensation Act and the large damages awarded under it, there is a field which needs an expert team of workers and with adequate animal houses at their disposal. America's forward push (Kuhn, 1950) in this branch of eye work is greatly to be commended, and should be followed by us. A panel of experts should be formed to give advice on each clinical problem as it arises. This panel must be fully backed by trained laboratory workers.

Intrauterine and birth diseases

We cannot mention intrauterine and birth diseases without coupling them with the names of Kate Campbell (1951) and Hugh Ryan (1951 and 1952) of Melbourne, who, in "pointing the bone" at excessive oxygen administration to the premature newborn, have eliminated that paramount blinder—retrolental fibroplasia. But is this the only bone to be pointed in the widening field of intrauterine and birth diseases? With the elim-

ination of the present isolationism in obstetrics and ophthalmology and the complete co-operation of both, a great deal of useful work could be done in birth injuries to the eyes and intrauterine infections (Hamilton, 1939). Are rubella—so ably brought to light by Sir Norman Gregg of Sydney (1941 and 1944)—and toxoplasmosis (Hogan, M. J., 1951) the only two intrauterine infections causing blindness? The Research Unit of the Department of Obstetrics of Melbourne University is following up the rubella problem (and needs the help of every ophthalmologist, every otologist, and every pediatrician in Australia) both in its intrauterine and adult forms. I suggest it is a problem for the Ophthalmic Research Institute of Australia.

The significance of the experiments of Millen and Woollam (1957) on the teratogenic effects of vitamin A and cortisone on the production of cleft palate in rat litters must not be overlooked. They were able with a specific technique to produce this defect in 100 percent of offspring of 12 litters. Other malformations of the skeleton were also evident. A completely new outlook on the relation of maternal hypervitaminosis and the production of congenital deformation has been revealed and needs our full evaluation. They appear to be as epoch making as the work of Sir Norman Gregg.

Blood

There seem to be at least five fields here which (with the aid of electrophoreses and other new methods) could with advantage be investigated. First the cholesterol and beta-lipoprotein blood levels in such diseases as central venous thrombosis, massive senile exudation retinitis, and obscure senile macular degeneration. There seems no doubt from collected evidence that the animal fats are certainly the "professor's friend," (A. M. J., 1957), or should we say "enemy." Corn oil instead of saturated animal fats is their tonic. In fact the vegetarians almost have the answer to the thrombosis problem.

Then we come to Sjøgren's syndrome and McLenchan's work on the vitamin A blood level as the result of possible liver damage in this disease. More liver function tests need to be done on the numerous cases of this disease.

On the other side of the picture we have Shipton's (1957) work on the lupus erythematosis phenomenon and its relation to Sjøgren's syndrome with the report of three positive cases.

The new story of agammaglobulinanemia and its relation to retinal hemorrhage (Martin, N. H., 1956), of sickle-cell anemia hemoglobin-C. and their relation to vitreous hemorrhage (Dacie, 1956; Rice, H. M., 1957); Wintrobe, 1956) and of cryglobulinaemia and its relation to obscure vascular obstruction (Ellis and Kloby, 1957) all need further elucidation, and the genetic pattern in each needs particular attention. In the light of modern hematology we may even be able to obtain reversal of diabetic retinal hemorrhage in the near future.

Dietetics

The recent work of Clements and Wishart in Tasmania on "A thyroid-blocking agent in the etiology of endemic goiter" (1956) has awakened our interest in dietetics and in the staple diet of Australian children—namely milk.

Dietetics is an almost untouched field of ophthalmologic research. How many ocular complaints of the fetus are due to malnutrition of the mother? How much school myopia is due to faulty diet? How often could senile cataracts and retinal degeneration be avoided by a revised diet? Can we afford to eat what and when we like? Do we know what the average man, woman, and child does eat? But we do know in Australia —in a land of plenty—that the average school child and the average clerical worker only have one normal meal daily—processed breakfast foods and sandwiches make up the other two inadequate meals. You have eliminated the word "sandwich" from your geographic nomenclature—I wish we in Aus-

tralia could eliminate sandwich from our dietetic nomenclature, for we still see cases of ophthalmoplegia, retrobulbar neuritis, and ocular hemorrhage from vitamins B and C deficiencies.

Gardiner (1956) has pointed out that myopic children are far more selective than average children in their dietetics, and he suggests that this selectivity aggravates their myopia.

Myself, a great exponent of adequate dietary, fell a victim of failing hearing which responded rapidly to vitamin B complex therapy. So is an "adequate diet" really a yardstick?

The field work that could have been done (and was not) after V. P. Day on the retrobulbar neuritis cases of Changi and Siamese camps would have revealed a wealth of information. The material was awaiting full investigation and the opportunity was lost. We must ever be grateful to Maynard (1946) for his very concrete contribution.

Summary

Australia's birth was crowned by the outstanding scientific researches of Sir Joseph Banks and Dr. David Solander who travelled with Capt. James Cook in the *Endeavour*.

The Ophthalmic Research Institute of Australia, blessed with the "D. W. Funds," hopes to finance effectively many aspects of ophthalmic research in Australia and particularly to encourage youth in this direction.

Further statistical surveys in the larger cities are imperative and in order to supplement rural surveys already completed.

The etiology of uveitis and its relation to the zoonoses, the effect of modern drugs on the glaucomas, and the role of inheritance in pediatrics and geriatrics need investigation.

Further studies on intrauterine and birth diseases, blood dyscrasias, and dietetics and their relation to ophthalmology are required.

Industrial ophthalmology so far neglected must be put in its right perspective in every industrial center. This is an undeveloped sphere in this large continent.

Several projects have already been financed by the Ophthalmic Research Institute of Australia and, as funds increase, it has other fields of research in mind.

Conclusion

I must, in closing, thank the president and officers of the Pan-Pacific Surgical Congress of 1957 for their invitation to come and speak to you today about the Ophthalmic Research Institute of Australia whose postal address is, 235 Macquarie Street, Sydney. I also bring you all greetings from its president, Dr. Archie Anderson, C.B.E., of Melbourne.

I must also thank the president of the Institute, and many colleagues in Australia for their advice in producing this paper.

105 Davey Street.

References

Alvaro, M. E.: The etiology and pathogenesis of uveitis. Tr. Ophth. Soc. U. Kingdom, **76**:697, 1956.

Anderson, J. R.: Detachment of Retina. Cambridge, 1931.

———: a. Blindness in private practice. M. J. of Australia, Nov. 4, 1939, p. 680.

———: b. Hydroophthalmia. Cambridge, 1939.

———: A pterygium map. XVII Concil. Ophth., **3**:1631, 1954.

Australian M. J.: (Leader) **1**:611, 1957.

Cameron, A. C.: Sir Joseph Banks. London, 1952.

Campbell, K.: Intensive oxygen therapy. M. J. Australia, July 14, 1951, p. 48.

Clements, F. W., and Wishart, J. W.: A thyroid blocking agent in the etiology of endemic goiter. Metabolism, **3**:623, 1956.

Dacie, J. V.: Practical Haematology. London, 1956.

Duke-Elder, S.: The Institute of Ophthalmology. Eighth Annual Report, London, 1956.

Dunphy, E. B.: The role of radioactive phosphorus in the diagnosis of ocular malignancy. Tr. Ophth. Soc. U. Kingdom, **76**:137, 1956.

Ellis, R. A., and Kloby, J.: Cryoglobulinemia. Am. J. Ophth., **43**:124, 1957.

Flynn, F.: Trachoma among natives of the northern territory. Australia M. J. Australia, **2**:269, 1957.

Gardiner, P. A.: Brit. M. J. Sept. 22, 1956, p. 699.

Gibson, J. L.: Ocular neuritis due to lead. Sydney, 1922.
Gregg, N. McA., Congenital cataract following German measles in the mother. Tr. Ophth. Soc. Australia, **3**:35, 1941.
———: Further observation on congenital defects in infants following maternal rubella. Tr. Ophth. Soc. Australia, **4**:119, 1944.
Hamilton, J. B., and Counsell, W. D.: Cause and prevention of blindness. Report Nat. Health & Med. Research Council. Appendix 7. 1937.
———: Injuries to the eyes resulting from birth. Tr. Ophth. Soc. Australia, **1**:84, 1939.
———: Blindness in Tasmania. Tr. Ophth. Soc. Australia, **2**:37, 1940.
———: Tasmanian blindness. Tr. Ophth. Soc. Australia, **3**:60, 1941.
———: Ocular complications in relapsing fever. Brit. J. Ophth., **27**:58, 1943.
———: The significance of heredity in ophthalmology. A Tasmanian survey, 1951.
———: Zoonoses in Ophthalmology. Tr. Ophth. Soc. Australia, **15**:72, 1955.
Hawkesworth, J.: An Account of the Voyages. Vol. III, London, 1773.
Hogan, M. J.: Ocular Toxoplasmosis. New York, Columbia, 1951.
Joyce, A.: Presidential address. Tr. Ophth. Soc. Australia, **9**:8, 1949.
Joyce, A., and Scott, K.: Treatment of intraocular tumors with radon. Acta XVII Concil. Ophth., 1954, p. 459.
Kimura, S. J., Hogan, M. J., and Thygeson, P.: Uveitis in children. Arch. Ophth., **52**:80, 1954.
Kuhn, H. S.: Eyes in Industry. St. Louis, Mosby, 1950.
Mann, I. C.: Ophthalmic survey of Kimberley Division of Western Australia. Perth, 1954.
———: Ophthalmic Survey of Eastern Goldfields area of Western Australia. Perth, 1954.
———: Ophthalmic Survey of Territories of Papua and New Guinea. Port Moresby, 1955.
———: Ophthalmic Survey of the South West Portion of Western Australia. Perth, 1956.
Martin, N. H.: Agammaglobulinaemia. Triangle, **2**:297, 1956.
Maynard, R. B.: Blindness amongst prisoners of war. Tr. Ophth. Soc. Australia, **6**:92, 1956.
Millen, J. A., and Woollam, D. H. M.: Influence of cortisone on teratogenic effects of hypervitaminosis A. Brit. M. J., July 27, 1957, p. 196.
Paul, S. D., and Leopold, I. H.: Tranquilizing agents. Am. J. Ophth., **42**:752, 1956.
Rice, H. M.: Hemoglobin-C. disease and trait. Brit. M. J., Jan. 5, 1957, p. 25.
Ryan, H.: Retrolental fibroplasia. Tr. Ophth. Soc. Australia, *11*:122, 1951.
———: Retrolental fibroplasia. Am. J. Ophth., **35**:329, 1952.
Shipton, E. A.: A contribution to the study of collagen diseases. M. J. Australia, **44**:911, 1957.
Smythe, R. H.: Veterinary Ophthalmology. London, 1956.
Streiff, E. B., and Babel, J.: Modern Problems in Ophthalmology. Basel Karger, 1957.
Sysi, R.: Effect of "myanesin" on intraocular pressure. Brit. J. Ophth., **39**:619, 1955.
Wintrobe: Clinical Haematology, Philadelphia, Lippincott, 1956.
Woods, A. C.: Cambridge, Thomas Young, 1954.
———: Endogenous uveitis, Baltimore, Williams & Wilkins, 1956.
Woollam, D. H. M., and Millen, J. W.: The effect of cortisone on the incidence to cleft palate induced by experimental hypervitaminosis. Brit. M. J., July 27, 1957, p. 197.

TORSION DEMONSTRATIONS WITH A GIMBAL-MOUNTED PROJECTOR*

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INTRODUCTION

Donder's and Listing's laws of ocular movements are very concise statements of the amount of torsion associated with every oblique position of the eyes. To describe or illustrate these two laws is one of the most difficult tasks in the teaching of physiologic optics. Due to an unfortunate choice of terms by Helmholtz, a great deal of confusion has arisen in the literature concerning these laws, and if one attempts to supplement a lecture or a demonstration with reading material, the situation is only worsened.

The terms torsion and cycloduction are used here in the sense recommended by Lan-

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caster.[1] In following his recommendations, torsion refers to the tilting of the vertical and horizontal meridians of an eye in a tertiary position. It is assumed that accommodation is relaxed and that the fellow eye is occluded. Cycloduction is defined as a rotation of the eye about its line of sight.

In attempting to analyze eye movements, at least three systems of axes may be used to describe these eye movements.

One system of axes was introduced by Fick.[2] In Fick's system, it is assumed that there is a fixed vertical axis and a horizontal axis which rotates about this fixed axis (fig. 1). Movements are described in terms of angles of longitude and latitude. This particular system corresponds exactly with the co-ordinate system which is used to describe points on the surface of the earth.

Helmholtz chose to describe eye movements in terms of a fixed horizontal axis which coincides with the line connecting the centers of rotation of the two eyes (the base line) and a vertical axis which rotates about this horizontal axis[2] (fig. 2). Movements are here referred to in terms of elevation above and below a horizontal plane and azimuth to the left or to the right in a plane of elevation. These co-ordinates, azimuth and elevation, are not to be confused with the terms which are used in naval gunnery involving a fixed vertical axis system.

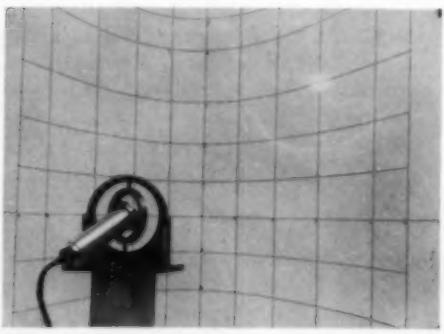

Fig. 1 (Knoll). Gimbal projector and screen arranged to demonstrate Fick's system of axes. The vertical axis is fixed with respect to the model. The arms of the projected cross are seen to coincide with the co-ordinates of longitude and latitude.

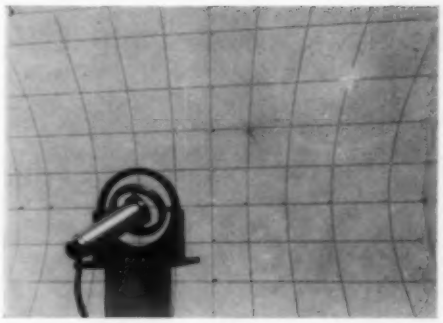

Fig. 2 (Knoll). Gimbal projector and screen arranged to demonstrate Helmholtz's system of axes. The horizontal axis is fixed with respect to the model. The arms of the projected cross are seen to coincide with the co-ordinates of elevation and azimuth.

Finally, the third system of axes is that system usually referred to as Listing's system, wherein the eye rotates about an axis lying in a vertical plane passing through the center of rotation of each eye. Listing's axis itself rotates about an anterior-posterior fixed horizontal axis (figs. 3, 4, and 5). A plot of the co-ordinates involved here projected on a plane surface would correspond to the co-ordinates on a tangent screen, and have been referred to as meridional direction and eccentricity.[3] Analyzing eye movements in terms of Listing's axes is not only convenient for designation of the direction of gaze of a given eye, but, in accordance with Listing's law, it also describes the torsion of the eye as it rotates in various directions of gaze.

As already pointed out, Fick's system corresponds to the co-ordinate system used on the surface of the earth. If one imagines an eye located at the center of the earth with the north pole above and the south pole below, eye movements may be described in terms of longitude and latitude. It is important to recall here that lines of longitude are great circles, whereas lines of latitude are small circles. If one can imagine that the earth is rotated through 90 degrees so that its axis coincides with the line connecting the centers

of rotation of the two eyes, the system of co-ordinates presented now corresponds to the system proposed by Helmholtz. In this system, the lines of elevation are great circles and the lines of azimuth are small circles. Keeping the earth's axis horizontal and turning it through 90 degrees so that it passes through the eye in an anterior-posterior direction, the eye would see the earth's co-ordinate system as described by Listing's system of axes. The co-ordinate system now corresponds to a polar projection of the earth. The lines of meridional direction are great circles and the lines of eccentricity are small circles.

As an eye moves from its primary position to a teritary position, there appears an increasing amount of torsion. The amount of torsion varies in direction and amount as latitude and longitude or azimuth and elevation are varied. For example, let us consider a monocular right eye movement (with accommodation relaxed) up and out according to Listing's law. If the direction of gaze is specified in terms of Fick's system of axes and co-ordinates, the eye would be extorted, whereas if the direction of gaze were specified in terms of the Helmholtz system of axes and co-ordinates, there would be an intorsion. These comments refer to the vertical and horizontal meridians of the eye.

A thorough understanding of these differences is essential in comparing the results which may have been taken on various types of instruments constructed either in accordance with Fick's system of axes, as in the case of the Synoptoscope and the Troposcope, or as one might have in a system utilizing Helmholtz's axes as in the Eikonometer and in the Orthorator.

With the gimbal-mounted projector, to be described, it is possible to demonstrate the following relationships which would apply to all monocular eye movements with accommodation relaxed in accordance with Listing's law.

1. The torsion of the vertical and horizontal meridians of the eye in tertiary positions of gaze.

2. The torsion direction (intorsion or extorsion) of the vertical and horizontal meridians is dependent upon the system of co-ordinates used to specify the direction of gaze.

3. The absence of torsion of the meridian coincident with the meridian along which the eye moves from a primary position to all other positions. The meridian perpendicular to this meridian will not be torted either. The absence of torsion of the vertical and horizontal meridians of the eye in all secondary positions of gaze is a special case of this more general relationship.

4. The cycloduction associated with great-circle eye movements from any secondary or tertiary position to other secondary and tertiary positions.

Apparatus

The demonstration apparatus consists of two parts, a gimbal-mounted projector and a plane projection screen located 10 inches from the center of the gimbal.

The projector consists of an illuminated, right-angled cross mounted behind a projection lens. The arms of the cross can be made to correspond to any mutually perpendicular meridians of the eye. The projection system is mounted in the inner ring of the gimbal as may be seen in Figure 1. The outer gimbal ring is mounted parallel to the screen, but is capable of being rotated about an axis perpendicular to the screen. In Figure 1, the gimbal is adjusted so that the vertical axis is fixed with respect to the base of the demonstration model. In Figure 2, the outer ring has been rotated so that the horizontal axis is fixed with respect to the demonstration model.

Since the projection surface is a plane, which would correspond to walls in the visual world, gnomonic projections of the co-ordinate systems have been used. The relationship between the co-ordinate lines in gnomonic projections and the projected cross is exactly as it would be if the cross were projected on a spherical surface on which the co-ordinate lines have been drawn. Exact

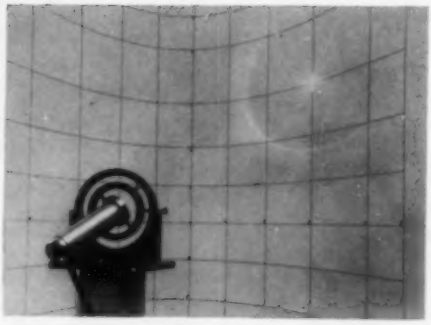

Fig. 3 (Knoll). The Gimbal projector is arranged to demonstrate Listing's system of axes. The screen shows the co-ordinates of longitude and latitude. If the model is thought to represent the right eye, extorsion is demonstrated.

angular magnitudes are not maintained, but these can be calculated. A virtue of gnomonic projections is that great circles project in straight lines, hence lines of longitude, elevation, and meridional direction may be drawn with a straight edge.

Figure 1 shows the gimbal and screen arranged in accordance with the system proposed by Fick and Figure 2 shows the gimbal and screen arranged in accordance with the system proposed by Helmholtz. In both cases, the original vertical and horizontal arms of the illuminated cross coincide exactly with the co-ordinate lines.

By locking the middle and outer gimbal rings together and rotating the projector about the inner axis, eye movements in accordance with Listing's law can be duplicated. Figure 3 shows the torsion when the eye moves in accordance with Listing's law when referred to Fick's system of co-ordinates. Assuming that the model represents the right eye, the tilt is in the extorsion direction. Figure 4 shows the eye in approximately the same position, but referred to Helmholtz's system of co-ordinates the tilt is now in the intorsion direction.

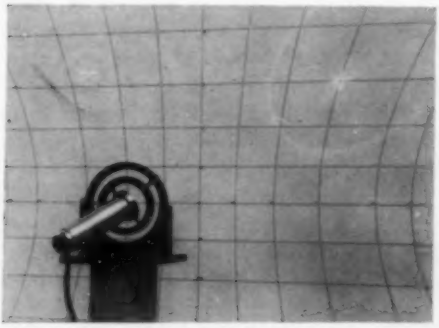

Fig. 4 (Knoll). The Gimbal projector is arranged to demonstrate Listing's system of axes. The screen shows the co-ordinates of elevation and azimuth. If the model is thought to represent the right eye, intorsion is demonstrated.

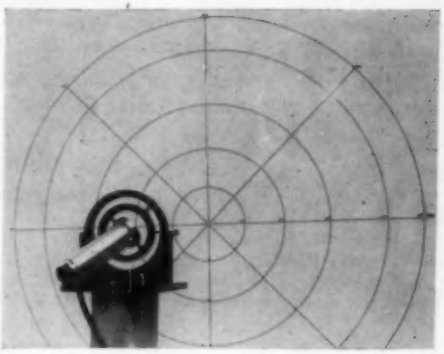

Fig. 5 (Knoll). The Gimbal projector is arranged to demonstrate Listing's system of axes. The screen shows the co-ordinates of meridional direction and eccentricity. There is no torsion for the particular meridians shown.

Up to this point, torsion of the vertical and horizontal meridians has been considered. If attention is directed to the retinal meridian corresponding to the direction of the eye movements, no torsion will be noted. This is illustrated in Figure 5. In this case, Listing's system of axes is demonstrated and the gnomonic projection of the co-ordinate system shown on the screen. One arm of the projected cross was oriented parallel to the direction of travel and it will be seen that there is no torsion of this meridian and the meridian at right angles to it.

Examples and figures given above demonstate the usefulness of the gimbal-mounted projector in illustrating the torsions associated with eye movements from the primary position to any tertiary position. The projector can be used to demonstrate the absence of torsion when the eye moves from the pri-

mary to any secondary position. It can also be used to demonstrate the fact that movements from any secondary or tertiary position to all other secondary or tertiary positions lying on a different meridian are associated with a cycloduction.

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References

1. Lancaster, W. B.: Terminology in ocular motility and allied subjects. Am. J. Ophth., **26**:122-132, 1943.

2. Helmholtz, H. von: Physiological Optics (English translation). (Published by the Optical Society of America.) Menasha, Wis., Banta, 1924, v. 3, p. 42.

3. Fry, G. A., Treleaven, C. L., and Baxter, R. C.: Specifications of the direction of regard. Am. J. Optics. and Arch. Am. Acad. Optics., 22:351-359, 1945.

FLASH BURNS IN THE RABBIT RETINA*

As a means of evaluating the retinal hazard from nuclear weapons

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Introduction

Retinal damage from radiant energy has been documented well in the literature[1] but Buettner and Rose were the first to emphasize the vulnerability of the eye to atomic explosions.[2] They pointed out that the image of the fireball, when focussed on the retina, has a thermal irradiance which is independent of the "inverse square law" out to distances where the resolution of the eye fails. For this reason thermal lesions of the retina represent a hazard at distances generally considered to be safe from the immediate effects of the atomic fireball. Only one case of retinal injury was reported from the Hiroshima and Nagasaki explosions;[3] these bombs were dropped in the morning under bright sunlight conditions when the pupillary diameter of the eye would be expected to be small. However, chorioretinal lesions in the rabbit at distances out to 42.5 miles from atomic explosions have been reported by Byrnes, et al.[4] These same authors have cited six cases of damage to the human retina from atomic fireballs.[5]

This investigation was initiated to obtain additional data in the laboratory on the production of thermal lesions in the rabbit retina. It is possible, within certain limitations, to simulate the thermal radiation from a fireball by means of a high intensity carbon arc. The spectral distribution from this arc approximates a black body of 5,800°K, though it is somewhat peaked in the visible region of the spectrum and notably deficient at wavelengths beyond 800 millimicrons. This arc placed at one of the foci of a 24-inch diameter ellipsoidal mirror with a front surface of aluminum has been used by the authors to produce experimental flash burns on animals and human volunteers.[6,7]

Optical modifications were necessary before this original flash burn apparatus could be used to produce lesions of one-mm. diameter or less on the rabbit retina. A previous report by us[8] describes these modifications, the spectral distribution of the arc, and some preliminary results on the thermal dose required to produce burns on the rabbit retina.

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* From the Department of Biophysics and The Titmus Ophthalmological Research Laboratory, Department of Ophthalmology, Medical College of Virginia. This research was supported by the U. S. Air Force under Contract No. AF-18(600)-1272, monitored by the USAF School of Aviation Medicine, Randolph Air Force Base, Texas.

The purpose of this paper is to report on threshold values of thermal dose required to produce a lesion in the rabbit retina as a function of rate of delivery of thermal energy, pulse shapes, and image size, and to discuss these factors in relationship to nuclear weapons. A method of photographing the thermal lesion during its production will be described and the clinical and histologic appearance of the lesions will be discussed.

Experimental apparatus

To obtain quantitative data on the thermal dose in cal./cm.^{2} required to produce a thermal lesion on the retina, the following factors must be known: the thermal irradiance, ϕ_c, in cal./cm.^{2}/sec. incident on the cornea, the pupillary diameter, D, at the time of exposure, the average transmission coefficient, k, through the ocular media for a given spectral distribution, the exposure time, t, in seconds, the diameter, d, of the image on the retina, and a form factor, f, to correct for the shadow of the carbon arc holder focussed on the retina. The formula used to calculate ϕ_r, the irradiance on the retina is

$$\phi_r = \frac{\phi_c \times D^2 \times k}{d^2 \times f} \text{ cal./cm.}^2\text{/sec.} \quad (1)$$

The dose Q_r on the retina for constant irradiance, ϕ_r (square wave pulse) or average irradiance in the case of irregularly shaped pulses is

$$Q_r = \phi_r \times t \text{ cal./cm.}^2 \quad (2)$$

The apparatus used to produce retinal lesions is shown schematically in Figure 1.

The thermal radiation source is a 24-inch army searchlight equipped with molded glass ellipsoidal mirror and modified to allow the use of Hitex positive and orotip negative carbons.[6, 8] These carbons are operated at 140 amp. giving an arc current density of 190 amp./cm.^{2} An irradiance of 25 cal./cm^2/sec. is obtained at the first water cooled aperture. The purpose of the second

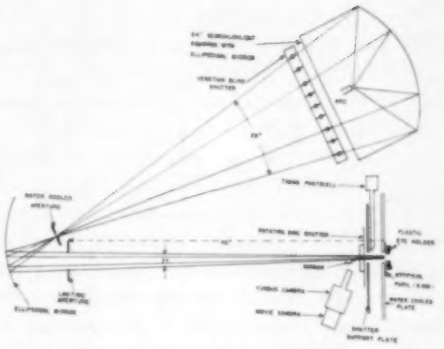

Fig. 1 (Ham, et al.). Schematic diagram of optical apparatus used to produce retinal burns.

ellipsoidal mirror is to reduce the angle of convergence from 28 to seven degrees in order to simulate the atomic fireball. Irradiance at the burn aperture ranges from 1.3 to 1.5 cal./cm.^{2}/sec. for the maximum cone of radiation.

Corneal irradiance, ϕ_c, is measured with a constant flow calorimeter placed flush with the water cooled brass plate. This calorimeter, originally designed for X-ray dosimetry,[9] is shown schematically in Figure 2. Distilled water is forced through the calorimeter at a constant flowrate by means of a pump consisting of a copper pipe three in. in diameter and 30 in. long; a piston, driven by a synchronous motor provides non-turbulent flow at 23 ml./min. Water in the copper

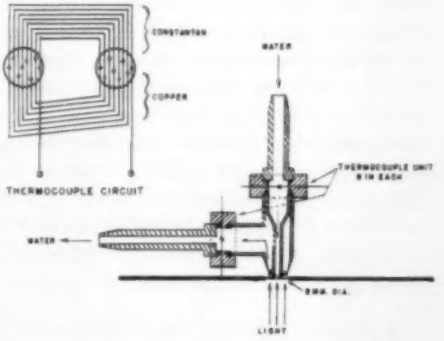

Fig. 2 (Ham, et al.). Schematic diagram of water calorimeter.

TABLE 1

CALORIMETER READING IN CAL./CM.²/SEC.

	H_2O	NRDL	NML
Trial 1	1.34	1.33	1.48
2	1.34	1.36	1.49
3	1.30	1.35	1.49
Av.	1.33	1.35	1.49

pipe is at temperature equilibrium with the room, while the water circulating through the brass plate defining the burn aperture is kept at room temperature by means of a heat exchanger. This arrangement prevents any large temperature gradient between calorimeter and brass plate.

Radiation strikes the black body receiver, a piece of shim copper, 8.0 mm. in diameter, coated with flat black paint, and is conducted to the water impinging normally on the receiver. The temperature difference between entrance and exit streams is measured by the two thermocouple units and registered on a Brown recorder. A built-in heater unit of nichrone wire (not shown in fig. 2) is used to calibrate the thermocouples; current and voltage input to this resistor are measured to 0.1 percent with precision instruments. The thermoelectric constant for the 16 junctions in series is 320 μ volts/°C. To insure accuracy, the H_2O calorimeter was calibrated against radiometers from two other radiation laboratories;* the results are listed in Table 1. The H_2O calorimeter and the NRDL radiometer which was calibrated on a carbon arc source agree to better than two percent; the NML radiometer was calibrated in terms of a standard tungsten source which probably accounts for the discrepancy of about eight percent between this instrument and the other two. It is estimated that the systematic error involved in determining ϕ_e with the water calorimeter is not more than five percent.

* Radiometers from the Naval Radiological Defense Laboratory, San Francisco, California, and from the Navy Materials Laboratory, Brooklyn, New York, were kindly loaned for this calibration.

Another possible source of error in measuring ϕ_e arises from the fluctuations in intensity of the carbon arc. The H_2O calorimeter is essentially an integrating instrument with a slow response time; short term variations in radiation flux would not be recorded. To investigate short term variations in irradiance a photocell was used to view a small area of the radiation beam striking the burn aperture. The output was fed to a Tektronics oscilloscope and the trace photographed for various exposure times. A series of six consecutive short term exposures gave an average trace height of 4.19 ± 0.165 cm. with a C.V. of four percent. For short exposure times (20-250 ms.) a random error of ± 5.0 percent in ϕ_e can be expected. This random error of five percent should be distinguished from the systematic error involved in calibrating the water calorimeter which is estimated also as five percent. A conservative over-all estimate of ϕ_e is 7.1 percent.

Since in vivo measurements of pupillary diameter are difficult and inaccurate, an artificial pupillary diameter of 8.0 mm. was inserted between the brass plate and the plastic eye holder. All rabbits were dilated to 9.0 mm. or better with atropine, thus assuring a pupillary diameter, D, of 8.0 mm. for all exposures reported in this paper. Errors in determining D are negligible in comparison to those of the other factors in equation.[1]

The transmission coefficient k through the ocular media of the rabbit has been reported in a separate paper.[10] The nine rabbit eyes examined provide an average transmission curve which, when superimposed on the spectral distribution curve of the Hitex carbon arc as measured with a Bausch and Lomb monochromator, give a transmission coefficient, $k = 0.78 \pm 0.02$. When the same curve is superimposed on the spectral distribution curve of a black body at 5,800°K (approximate average temperature of an atomic fireball during its second phase), the transmission coefficient $k = 0.80$.

It is generally assumed that the actual measurement of the burn lesion on the retina may be used to calculate the thermal dose to the retina. That this is a questionable procedure will be shown in a subsequent section of this paper where actual fundus photography of the burn lesion during production demonstrates that the lesion size is a function of exposure time.

Calculations of thermal dose to the retina in this paper are based upon a determination of the image size, d, on the retina during irradiation. An accurate measurement of d is difficult and probably represents the greatest source of error in calculations based upon equation 1. The limiting aperture shown in Figure 1 defines geometrically the solid angle of radiation incident on the cornea.

For a rabbit eye having a 10-mm. focal distance between nodal points and retinal plane, the size of the retinal image may be calculated in terms of a lens of 10-mm. focal length. Knowing the diameter of the limiting aperture and its distance from the cornea, the ratio of this diameter to that of the retinal image is inversely proportional to the ratio of the object and image distances.

Short exposure fundus photography of the image diameter on the rabbit retina was used to verify this calculation. Care was taken to measure the magnification factor of the fundus camera under the conditions of the exposure. Results are tabulated in Table 2.

From Table 2 it is apparent that the calculated image diameter and that determined by fundus photography agree to within ±10 percent. It is concluded that while calculation of image size, d, in terms of a 10 mm. focal length lens represents an idealization for the rabbit eye, it is, nonetheless, preferable to a measurement of lesion size after burn production, since it can be demonstrated that lesion size depends markedly on the time of exposure (a conduction phenomenon); whereas, image size can be assumed confidently to be invariant during the exposure times employed in this report (250 milliseconds or less).

TABLE 2

FUNDUS CAMERA MEASUREMENTS OF IMAGE SIZE

Diameter Limiting Aperture in Inches	Fundus Camera Diameter of Image in Cm.	Calculated Diameter of Image in Cm.
4.875	1.33	1.2
4.50	1.16	1.1
3.00	0.66	0.71
1.625	0.41	0.39

The variation in ocular constants from rabbit to rabbit is another factor to be considered in estimating the image diameter, d. To investigate this factor, 19 rabbits were examined for corneal curvature (dioptric power) and refractive error. Enucleated eyes from three rabbits were used also to measure the distance along the geometric axis from cornea to choroid and the distance from the posterior pole of the lens to the choroid. Results are listed below:

Mean weight 4.242 ± 0.665 kilograms

	Axis	Diopters
Dioptric power (O.D.)	90°	41.7 ± 2.4
Dioptric power (O.D.)	180°	41.1 ± 2.1
Dioptric power (O.S.)	90°	41.3 ± 2.2
Dioptric power (O.S.)	180°	41.2 ± 2.1
Refractive error (O.D.)		2.5 ± 0.7
Refractive error (O.S.)		2.7 ± 0.6

It does not appear from these data that there is a significant difference in the dioptric power or refractive error in either eye of the rabbit or between rabbits. The distance along the geometric axis from cornea to choroid minus the distance from posterior pole of the lens to choroid was 10.4 and 10.7 mm. in the three rabbits measured. These are difficult and approximate anatomic measurements; additional data from the School of Aviation Medicine* confirm the uniformity of the rabbit eye and a focal distance of approximately 10 mm. Realizing the importance of image diameter in calcula-

* Unpublished data kindly furnished by Dr. H. W. Rose, Department of Ophthalmology, School of Aviation Medicine, Randolph Air Force Base, Texas.

tions of the thermal dose to the retina, a further check was attempted; freshly enucleated rabbit eyes were held at the burn aperture and a photograph of the image taken through a hole trephined in the sclera. When allowance was made for the position of the photographic plate with reference to the retinal surface, a rough estimate of 10 mm. for the focal distance was obtained. Experience indicates that the best estimate of image diameter is obtained in terms of the geometry of the optical system based on a 10-mm. focal distance for the rabbit eye.

The form factor, f, in equation 1 arises from the fact that the carbon arc holder is focussed faithfully on the retina when limiting apertures of three in. diameter or greater are used to define the image size. The value of f depends upon the diameter of the limiting aperture since the shadow of the holder represents a different proportion of the area of the aperture as the diameter of the latter is changed. Photographs of the shadow, at the limiting aperture for diameters of 4.875, 4.50, 4.0 and 3.0 in., were taken; an accurate measurement of the shadow area was obtained with a planimeter and the ratio of this area to the aperture area used to calculate f. Values of f for different aperture and image diameters are given in Table 3.

For apertures with diameters less than three in. the form factor becomes 1.0, since the hole is placed deliberately off-center to avoid the shadow and obtain maximum irradiance. Retinal irradiance, ϕ_r, is independent of limiting aperture diameter except for this form factor; while ϕ_e is directly proportional to the square of the limiting aperture, the image diameter, d, is inversely proportional to the diameter of the limiting aperture so that ϕ_r as calculated from equation 1 remains constant. From a theoretic standpoint the apparatus is capable of producing lesions of any desired size from 1.2-mm. diameter down to that aperture where resolution fails; in actual practice no lesions are observable for image diameters of 0.12 mm. or less, even for exposure times of one second and irradiances of 70 cal./cm.^{2}/sec. on the retina.

Exposure times were controlled by a specially designed shutter shown in Figure 3. It consists of a flag (3) and a rotating disc (2) with a 90 degree opening; the auxiliary equipment provides synchronization between rotating disc and flag and a mechanism for cocking and triggering the shutter. The disc is rotated by a 0.25 hp. d.c. motor through the reducing gears 11A and 11B. The flag shields the burn aperture (4) from the radiation beam until the mechanism is triggered by lever (7), at which time the flag drops down, allowing an exposure as the 90 degree slot revolves past the burn aperture. Exposure times is de-

TABLE 3

THE FORM FACTOR F AS A FUNCTION OF LIMITING APERTURE AND IMAGE DIAMETERS

Diameter of Limiting Aperture in Inches	Form Factor	Diameter of Image in Mm.*
4.875	0.91	1.2
4.50	0.873	1.1
4.0	0.865	0.98
3.0	0.88	0.71
1.0	1.0	0.24
0.75	1.0	0.18
0.50	1.0	0.12

* Calculated for an object distance (limiting aperture to cornea) of 42 inches.

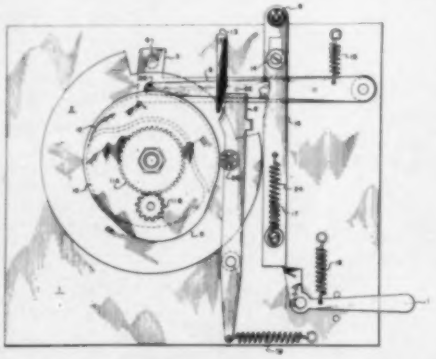

Fig. 3 (Ham, et al.). Schematic diagram of high-speed rotating disc shutter.

termined by the angular velocity of the disc which is controlled by varying the armature voltage to the d.c. motor. Exposures ranging from 10 milliseconds up to several seconds can be provided by changing the gear ratios.

The slot shown in Figure 3 produces a square wave of constant irradiance. Thermal pulses of any desired shape may be produced by altering the shape of the slot. In addition to square pulses, four types of pulses have been used by varying the slot shape. Since the revolving disc is within 0.25 in. of the cornea and in the focal plane of the optical system, the size and shape of the retinal image will remain constant, while the irradiance, ϕ_r will be controlled by the irradiated area on the cornea.

Exposure times are measured by a photocell shown schematically in Figure 1. Light passing through the slot to the burn aperture during an exposure actuates the photocell which controls a gating circuit; this circuit allows the output of a 10 kc. oscillator to feed into a decade scaler. Thus, each exposure is read directly on the scaler to the nearest 0.1 millisecond. Inaccuracies in exposure time t are completely negligible in comparison to measurements of ϕ_c, k, d, and f.

Both systematic and random errors are inherent in the calculation of ϕ_r by means of equation 1. Assigning seven-percent error to ϕ_c, 2.5 percent to k, and 10 percent to d, the error in ϕ_r is estimated to be about ± 21 percent. Since the exposure time is measured to better than 0.1 percent, Q_r from equation (2) would also be ± 21 percent for the total error.

Retinal burn procedure and fundus photography

Chinchilla gray rabbits, mature and of male sex, were used; their body weights ranged from 3.0 to 5.0 kg. Animals with exceptionally light or excessively dark pigmentation of the fundus were eliminated from the study. In all rabbits exposed, the nictitating membrane was excised, the pupils dilated to 9.0 mm. or more with one-percent atropine, and sodium nembutal (25 mg./kg. body weight) injected intravenously for anesthesia.

The anesthetized animal is placed upon an adjustable platform behind the burn aperture, the eye being held lightly but firmly in place against the plastic annulus shown schematically in Figure 1. The venetian blind attached to the searchlight housing remains practically closed during this procedure, allowing enough radiation to form a retinal image which can be seen in the fundus camera but not enough to damage the fundus irreversibly. Manipulation and co-ordination between the fundus camera observer and his team mate holding the rabbit make it possible to place the image on a desirable portion of the retina. With experience, it has proved feasible to produce several burn lesions on the same fundus without overlapping.

When the observer is satisfied as to the location of the image, he raises a lever which initiates the following sequence of events: the rotating shutter shown in Figure 3 slides into a fixed position, intercepting the radiation beam by means of the flag; at the same time the mirror is removed from the beam and a microswitch energizes a solenoid which opens the venetian blind, allowing the full intensity of the radiation beam to strike the shutter flag. The observer operates lever (7) which triggers the shutter. After the exposure through the slot in the rotating disc, the flag returns to its original position between the burn aperture and the radiation beam before the disc can complete a revolution and produce a second exposure. Upon lowering the lever which slides the shutter back into its original position, the venetian blind closes and the operation is over. The entire procedure requires less than a second.

The method outlined above is not suitable for fundus camera photography during the production of the burn because the small

mirror is removed from the beam to allow full irradiance to the cornea. Photography during the burning process is accomplished by employing a Compur shutter in place of the revolving shutter and keeping a tiny mirror fixed in position. This mirror reduces by 10 percent the irradiance, ϕ_e, but does not cast a shadow on the retina, since it is close enough to the cornea to be within the focal plane of the optical system.

Exposure times of 0.5 sec. or more are used to photograph the progress of the lesion. The camera is triggered automatically just prior to opening the Compur shutter and runs at 70 frames per sec. until stopped manually. Fundus photography at 70 frames per sec. was employed at an early stage of the investigation; a total of 12 Kodachrome, 16-mm. films were exposed. These proved invaluable in guiding the research program.

Figure 4 illustrates one of these films. Blanching of the retina as seen after several exposed frames suggested that this might be used as a criterion of irreversible damage. Calculations based on 14 burns to 10 animals gave 3.56 ± 0.65 cal./cm.^{2} as the thermal dose required to produce blanching for a retinal image diameter of 1.1 mm. When an image diameter of 0.71 mm. was used, the dose to produce blanching was 4.93 ± 1.33 cal./cm.^{2}, thus illustrating the effect of image size upon the burn threshold.

These Kodachrome films when viewed on a screen with a movie projector present some interesting phenomena. During the first few frames a bright red patch with retinal anatomic details is visible and the shadow of the carbon arc holder can be seen. As the exposure continues, a whitish gray blanching develops within the red patch and progressively grows into a kidney shaped area surrounding the shadow of the carbon arc holder. This blanched area gradually expands until it erases the shadow of the arc holder and covers the entire irradiated area by the 60th to the 70th frame.

At a later stage in the research program it was discovered that for short exposure times (20 to 250 ms.) corresponding to low doses of thermal energy an ophthalmoscopically observable lesion would develop on the rabbit retina two to three minutes after the exposure. The lesions were invariably kidney shaped for limiting apertures of three-in. diameter or greater, were difficult to see, and exhibited a yellowish tinge. These observations led to the concept of a minimal lesion which could be used as a sensitive index of irreversible change in the retina. Histologic data support this arbitrary but valuable criterion for minimal damage. Fundus photography during burn production has been discarded as a quantitative method of determining burn threshold and a time consuming but more sensitive technique developed; it consists of varying the exposure time from shot to shot while holding ϕ_r and d constant, and waiting five minutes before evaluating the result. Ophthalmoscopic observation provides a yes or no answer, burn or no burn. Probit analysis is utilized to evaluate the data in terms of a RD-50 thermal dose (that dose which produces a minimal lesion within five minutes in 50 percent of the exposures).

The hit-or-miss technique has been used exclusively to study the effects of rate of delivery of thermal energy, image size, and pulse shape. The special shutter described in Figure 3 was designed for this purpose. A total of 163 rabbits involving 1,298 exposures, an average of four exposures to each eye, has been used.

Fundus photography during progress of the burn leads to a better understanding of the pathogenesis of thermal injury to the retina. It provides a reasonable explanation of the kidney shaped lesion, and demonstrates graphically that lesion size is less than image size for short exposures. Furthermore, it gives some insight into the conduction phenomenon going on within the retina during the influx of thermal energy and helps to explain why the burn threshold is a function of image size. It seems natural to postulate that the highest temperatures on the retina will be at the center of the image,

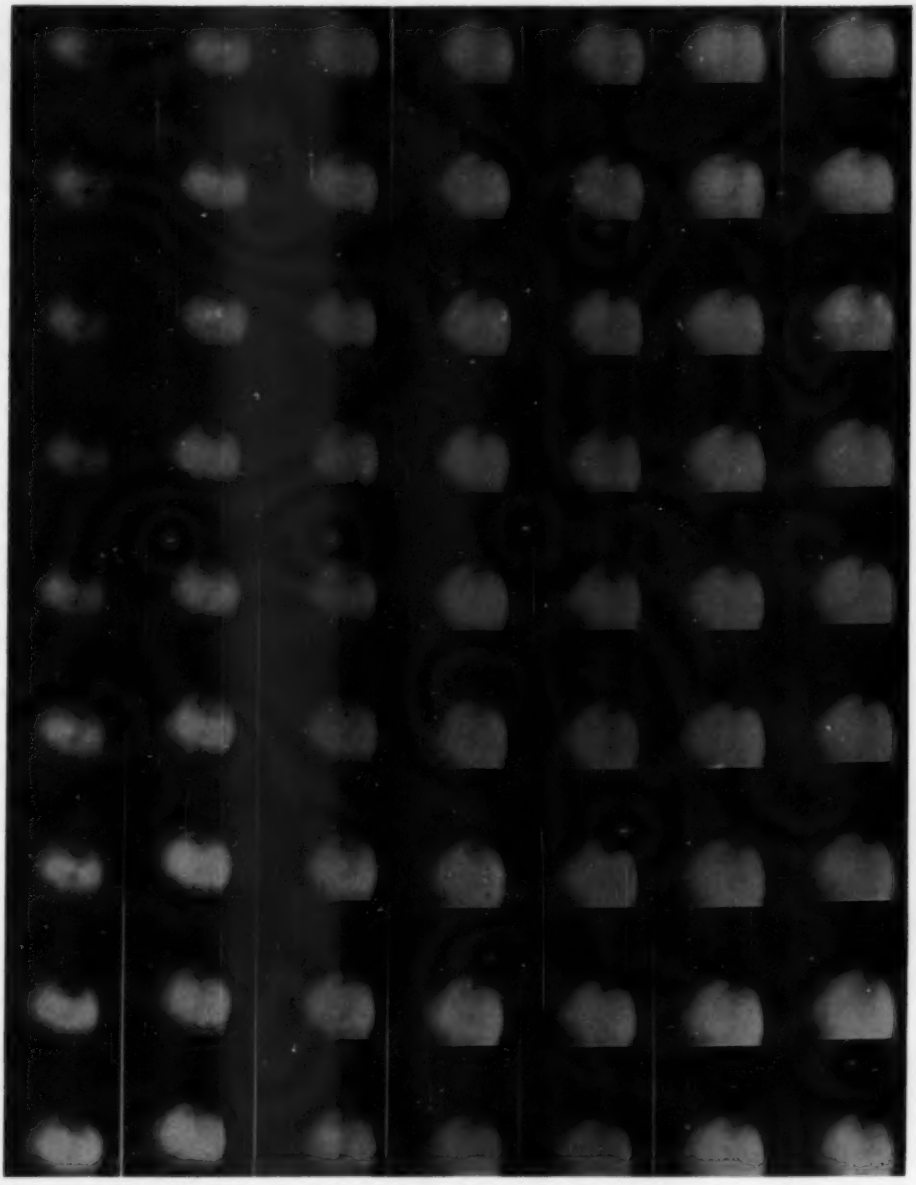

Fig. 4 (Ham, et al.). Photo sequence taken with fundus camera at 70 frames per sec. Read top to bottom, left to right.

since heat conduction is proportional to the thermal gradient and this will be least at the center of the image and greatest at the edges. For the image on the retina of an atomic fireball whose diameter grows rapidly during the first 100 milliseconds after detonation, this phenomenon will be exaggerated. While the thermal dose delivered by the first pulse from a fireball may not be sufficient alone to produce a lesion at moderate distances from ground zero because of the rapid dissipation of heat by the tiny image diameter, it, nonetheless, contributes energy at the center of the image during the first few milliseconds; this is followed by a large input of thermal energy over an increasingly larger image diameter during the next 100 milliseconds. The highest temperatures at all times will be at the center of the image. This may help to explain the crater effects observed by Byrnes and Rose,[4, 5] on lesions in humans and rabbits at intermediate distances from the explosion. At close distances to the detonation where the image of the fireball on the retina during the first pulse approaches reasonable dimensions and the irradiance rises rapidly to formidable values, the explosive effects on the retina described by these authors occur.

The dependence of threshold thermal dose upon rate of energy input to the retina has been investigated for several image diameters on the retina ranging from 1.1 mm. to 0.18 mm. The biologic criterion in all cases was the RD-50 to produce a minimal lesion within five minutes after exposure. Square wave pulses (⎍⎍) ranging in duration from 20 ms. to 250 ms. were used. Four sets of values for the retinal irradiance ϕ_r were obtained by interposing neutral gray filters in the radiation beam. These filters did not change the spectral quality of the radiation. Irradiance at the cornea, ϕ_e, was measured at the beginning and the end of the experimental run, the mean value being taken. The pupillary diameter, D, was always eight mm.

A typical probit analysis of an experiment using the three in. diameter limiting aperture is shown in Table 4. Irradiance, ϕ_r, was 49.6 cal./cm.^{2}/sec. as calculated by equation 1. The retinal dose, Q_r, given in column 1 was calculated for each exposure by means of equation 2. The time t for each exposure was measured to 0.1 ms.; t was varied at will by means of a variac which controlled the angular velocity of the shutter disc. (—) indicates no burn; (+) indicates a burn.

A complete summary of all exposure data, including that obtained for various pulse shapes, is given in Table 5. In Figure 5, ϕ_r, in cal./cm.^{2}/sec., is plotted against the average exposure time, t, in milliseconds, for constant irradiance (⎍⎍) exposures. Each curve represents a different image diameter d and the family of curves demonstrates how reciprocity failure depends upon image size. One data point for a 0.75 in. diameter limiting aperture (d = 0.18 mm.) appears in the upper right hand corner of Figure 5. It was not possible to obtain minimal lesions for exposure times less than 200 ms. with this aperture because the carbon arc source was unable to provide the necessary irradiance. The curves are dotted beyond the experimental points to illustrate their tendency toward convergency as the exposure time decreases. It is unfortunate that data in this region are not available because of limitations in the radiant source. True reciprocity would be represented by a hyperbola, $\phi_r \times t = \text{constant}$. It is apparent that failure to obey the reciprocity relation increases markedly as the diameter of the image on the retina decreases, until at image diameters of 0.18 mm. it becomes almost a straight line.

Another method of depicting the data is shown in Figure 6, where the thermal dose, Q_r, in cal./cm.^{2} is plotted against the exposure time, t, in milliseconds. Here, failure to obey the reciprocity relationship is illustrated by the increasing slope of the family of lines as the image diameter decreases. The lines are dotted beyond the experi-

TABLE 4

A TYPICAL EXPERIMENT ILLUSTRATING THE RD-50 CALCULATION

+ = lesion	Q_r in cal./cm.² − = no lesion		Probits
1.48 −	1.75 −		
1.68 −	1.73 −		11 exposures
1.71 −	1.74 −		1 lesion
1.72 −	1.74 −		9.1% probit = 3.67
1.75 +	1.75 −		Av. dose = 1.71 cal./cm.²
	1.75 −		
1.77 −	1.77 +		8 exposures
1.78 −	1.78 +		3 lesions
1.79 +	1.79 −		37.5% probit = 4.68
1.79 −	1.80 −		Av. dose = 1.78 cal./cm.²
1.80 −	1.82 −	1.83 +	
1.82 −	1.82 −	1.84 +	15 exposures
1.82 +	1.82 +	1.85 +	7 lesions
1.82 +	1.83 −	1.86 −	46.7% probit = 4.92
1.82 −	1.83 +	1.90 −	Av. dose = 1.83 cal./cm.²
1.91 +	1.93 −		
1.91 +	1.94 +		9 exposures
1.92 −	1.96 +		7 lesions
1.92 +	1.96 +		77.8% probit = 5.77
	2.2 +		Av. dose = 1.96 cal./cm.²

(Limiting Aperture = 3″ diam. ϕ_r = 49.6 cal./cm.²/sec.; D = 8 mm.; d = 0.71 mm.; f = 0.88; k = 0.78; ϕ_R = 0.468 cal./cm.²/sec. 75% transmission, gray filter in beam; 43 exposures on 5 rabbits.)

RD-50 = 1.85 cal./cm.² as read off probit regression line.

$$\text{Av. } t = \frac{1.85}{49.6} = 37.3 \text{ ms.}$$

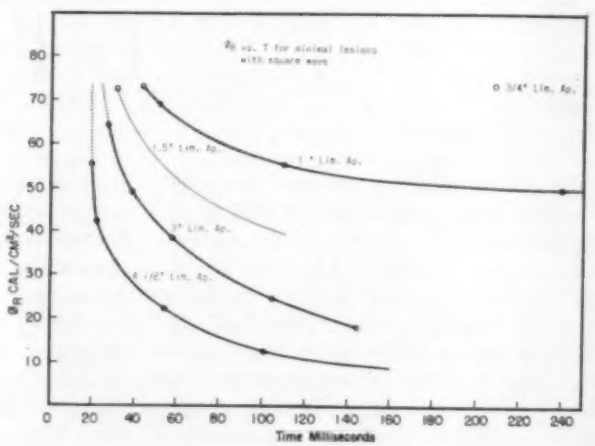

Fig. 5 (Ham, et al.). Retinal irradiance vs. time for minimal lesions with the square wave at various retinal image diameters.

TABLE 5

SUMMARY OF ALL EXPOSURE DATA

Waveform	Lim. Ap. Size Inches	d Retinal Image Diam. mm.	ϕ_R Average cal./cm.²/sec.	RD_{50} cal./cm.²	c.v. %	t Av. Exp. Time—ms.	No. Exposures	No. Rabbits
	4.5	1.1	55.6	1.09	7.7	19.6	58	11
"	4.5	1.1	42.6	0.92	8.8	21.6	58	10
"	4.5	1.1	22.0	1.25	5.0	56.8	61	10
"	4.5	1.1	14.2	1.31	2.0	92.0	65	10
"	4.5	1.1	10.7	1.74	0.98	163.0	49	6
"	3.0	0.71	65.0	1.75	6.0	26.9	50	8
"	3.0	0.71	49.6	1.85	1.9	37.3	43	5
"	3.0	0.71	39.7	2.27	1.4	57.2	36	5
"	3.0	0.71	25.8	2.70	0.66	105.0	27	3
"	3.0	0.71	19.3	2.78	0.63	144.0	39	5
"	1.5	0.36	73.0	2.18	2.1	29.9	39	4
"	1.0	0.24	69.6	3.47	0.95	49.9	27	2
"	1.0	0.24	55.6	6.06	8.4	109.0	52	6
"	1.0	0.24	51.1	12.2	1.75	239.0	35	5
"	0.75	0.18	74.2	15.4	3.7	207.5	14	2
	4.5	1.1	37.9	1.29	4.1	34.1	40	4
"	4.5	1.1	28.1	1.45	1.3	51.5	43	4
"	4.5	1.1	20.5	3.14	1.75	155.4	38	4
"	4.5	1.1	12.0	2.96	0.71	246.7	41	4
	4.5	1.1	39.9	1.48	1.7	37.1	37	5
"	4.5	1.1	29.0	1.54	0.62	53.1	39	5
"	4.5	1.1	20.8	2.50	0.43	120.2	38	6
"	4.5	1.1	11.7	2.87	0.22	245.2	41	5
	4.5	1.1	44.7	0.98	4.0	21.9	42	5
"	4.5	1.1	31.7	1.10	1.7	34.7	38	4
"	4.5	1.1	22.5	1.60	1.6	70.9	38	3
"	4.5	1.1	13.1	3.18	1.2	243.0	39	4
	4.5	1.1	46.8	1.06	2.3	22.6	41	4
"	4.5	1.1	33.9	1.17	3.0	34.3	42	4
"	4.5	1.1	24.7	1.74	1.6	70.4	44	6
"	4.5	1.1	14.2	2.16	0.5	152.0	44	4
TOTAL							1,298	163

mental data points to illustrate their tendency to converge to a thermal dose of approximately 1.0 cal./cm.². For relatively large image diameters (1.1 mm.), the departure from reciprocity is small, the threshold dose ranging only from 1.0-1.7 cal./cm.² for exposures over the range 20-160 ms. In the case of small image diameter (0.24 mm.), the departure is marked, ranging from 3.5-12.2 cal./cm.² for an exposure interval of 50-240 ms.

This drastic departure from reciprocity for small image sizes can be explained qualitatively by the increased efficiency of conduction to the surrounding tissues as the size of the cone of radiant energy on the retina decreases. For example, it was not possible to produce an observable lesion in the rabbit retina when a limiting aperture of 0.5-inch diameter was used to define the cone of radiation incident on the cornea, even with an irradiance of 70 cal./cm.²/sec. and an exposure time of 1.14 sec. The image diameter on the retina in this case was

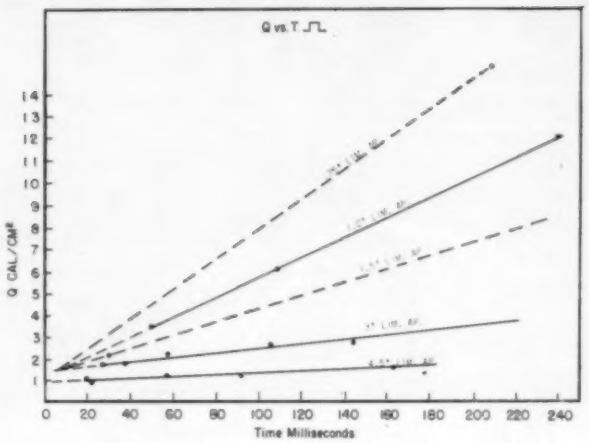

Fig. 6 (Ham, et al.). Threshold dose vs. time with the square wave at several retinal image diameters.

0.12 mm. The natural assumption here is that thermal energy at input values up to 70 cal./cm.²/sec. is conducted away to the surrounding tissue so rapidly that the temperature on the retina does not reach a value which will produce irreversible damage. Undoubtedly, the vitreous humor plays a role in this efficient dissipation of energy.

Henriques[11] has developed a theory of thermal damage which has been discussed critically by Fugitt.[12] The skin damage integral is not readily applicable to retinal tissue bathed in vitreous humor; furthermore, the assumptions underlying this interesting attempt to apply rate process theory to thermal injury are questionable. Fugitt* has analyzed the data shown in Figures 5 and 6 in terms of his heuristic equation by plotting in t vs. $1/\phi_r$. While there is some evidence that these data may be interpreted as the simultaneous combination of two different rate processes, it is not as convincing as that shown for Mixter's data.[13] No experimental data on time-temperature relationship at the retina during irradiation are available.

We are of the opinion that biologic changes capable of observation by ophthalmoscope are too gross to be interpretable in terms of rate process theory. Basic studies of this nature are best pursued with a single molecular species or a mixture of two or more species.

The dependence of threshold thermal dose upon retinal image size has profound bearing on the retinal hazard from nuclear explosions. Flash burns to the skin do not exhibit this phenomenon to the best of our knowledge. This does not seem surprising when orders of magnitude are considered; the retinal image sizes considered here range from 1.1 mm. to 0.12 mm.; whereas, most experimental flash burn studies on unprotected skin involve areas of several cm.² Thermal gradients of appreciable magnitude would occur only at the edges of these relatively large areas. Figure 7 shows graphically the dependence of threshold dose on image size. Threshold dose, Q_r, in cal./cm.² is plotted against retinal image diameter in mm. for square wave exposures. Each curve represents dose vs. image size at a specific value of irradiance. For the maximum irradiance value of 74 cal./cm.²/sec. it was necessary to extrapolate the experimental data in Figure 5 as shown by the dotted portions on the curves.

Examining the family of curves in Figure

* We are indebted to Dr. Charles H. Fugitt for his analysis of our data and his stimulating criticism.

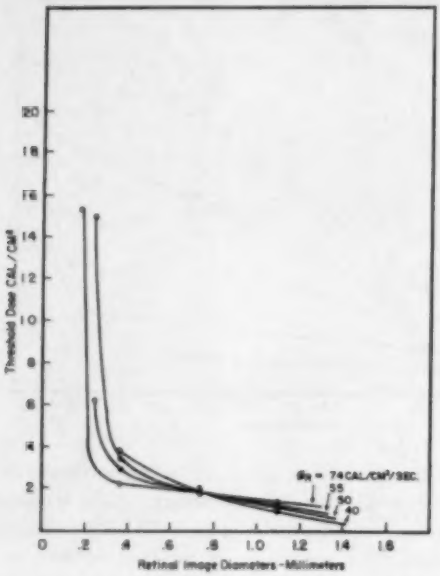

Fig. 7 (Ham, et al.). Threshold dose vs. retinal image size for several retinal irradiances.

7, it should be noted that when the image diameter decreases below 0.3 mm. the threshold dose increases dramatically. The cross-over point at approximately 0.8 mm. is interesting; here, different irradiances require the same threshold dose. Apparently, rate of energy input (ϕ_r) and thermal dissipation to surrounding tissue reach dynamic equilibrium at this image size and reciprocity is obeyed for irradiances ranging from 40 to 74 cal./cm.²/sec. The shadow from the carbon arc holder may have some influence upon this anomalous behavior at d = 0.8 mm. The presence of this shadow within the image area is conducive to an efficient dissipation of energy by conduction. The effect of the shadow is to increase the thermal dose necessary to produce a minimal thermal lesion. However, the shadow has no effect on the thermal dose at image sizes of 0.36 mm. or less, since the limiting apertures producing these images are displaced deliberately off-center to avoid the shadow of the carbon arc holder.

The Effect of Pulse Shape upon the Thermal Threshold

The special shutter described in Figure 3 can be modified to produce pulse shapes other than square waves. Four types of pulses have been studied: a sawtooth pulse (◺), the reverse sawtooth (◿), a trapezoidal pulse (⏢), and a spiked pulse (⩚). The two types of sawtooth pulse were designed to study the influence of rapid vs. gradual rise in irradiance for equal thermal doses. The trapezoidal pulse was designed to simulate grossly the second phase of the atomic fireball as described in "Effects of atomic weapons."[14] The irradiance rises rapidly to a maximum value and recedes more gradually to where it is cut off sharply by the blink reflex which for man is about 100 ms. The rabbit blink reflex takes longer (200 to 250 ms.). The spiked pulse represents an attempt to duplicate the first pulse of the fireball, followed by the main radiation phase.

An illustration of the four types of pulses is provided in Figure 8 which consists of actual trace photographs taken on a Tektronics oscilloscope by means of a photocell. Successive traces of each pulse type were photographed for planimeter measurements to determine experimentally the fraction of the square wave dose delivered by the pulse. For example, the average irradiance during a sawtooth exposure is 58.9 percent of the maximum irradiance as measured by the calorimeter; the thermal dose is calculated by multiplying the average irradiance by the exposure time. Only the 4.5-inch diameter limiting aperture is used in studying the various pulse shapes, so that image diameter will be constant at 1.1 mm. The biologic criterion is again the RD-50 dose to produce a minimal lesion within five minutes after exposure. A complete summary of the pulse data has already been given in Table 5 which also lists the square wave data.

Column 5 in Table 5 gives the RD-50 dose in cal./cm.² with the standard devia-

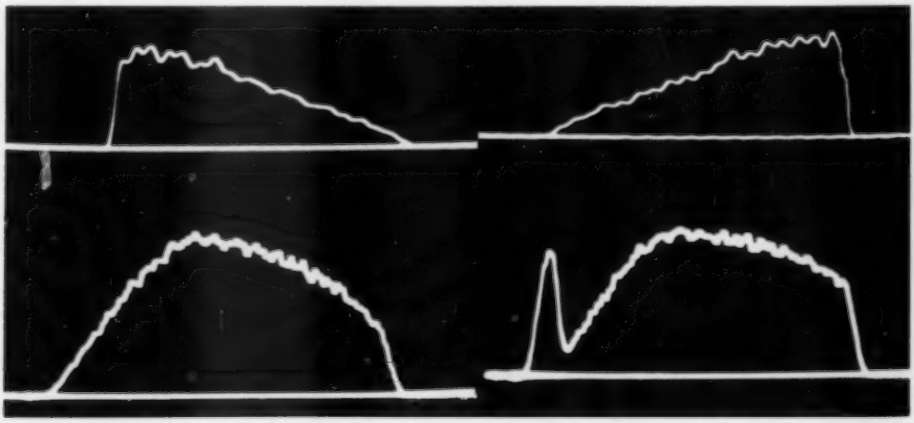

Fig. 8 (Ham, et al.). Oscillograph traces of the four pulse shapes used in this study.

tion of each probit analysis expressed as a percentage or c.v. The c.v. is less than 10 percent for each determination of dose and can be taken as a criterion of the precision of the data. It is difficult to separate the systematic errors from the random variables but the c.v.'s listed in Table 5 give a good estimate of the latter. It should be noted that the largest errors occur for the shortest exposure times; this is attributed mainly to random fluctuations in the intensity of the carbon arc. The over-all accuracy which includes both systematic and random errors is estimated at 21 percent but the data are reproducible to within a precision of 10 percent.

A plot of average irradiance vs. exposure time is given for the four pulse shapes in Figure 9. An alternate plot of thermal dose vs. exposure time is shown in Figure 10. The square waves taken from the previous data in Figure 6 are also shown in Figure 10 for comparison. There does not seem to be any significant difference between the two types of sawtooth pulses; in fact, the data do not show any major differences for any of the four pulse shapes. There does seem to be a slight tendency toward divergency between the pulses in the middle range of exposures (100 to 180 ms.) but there is a definite trend toward convergency at both ends of the exposure range.

Comparison of the four pulses with the square pulse producing a 1.1 mm. image diameter on the retina shows that the square pulse is more efficient in producing a minimal lesion except at the short exposure times. For example, exposures of 100 ms. duration produce a minimal lesion for an irradiance of 14 cal./cm.^{2}/sec. in the case of a square pulse, whereas it requires an average irradiance of approximately 20 cal./cm.^{2}/sec. for the other pulse shapes. This anomalous behavior is not apparent

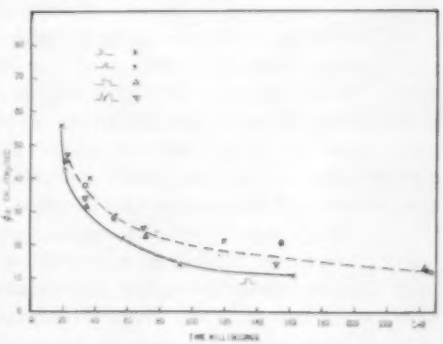

Fig. 9 (Ham, et al.). Retinal irradiance vs. time for minimal lesions with the 4.5-inch limiting aperture (solid line). Dashed line, average for the four pulse shapes.

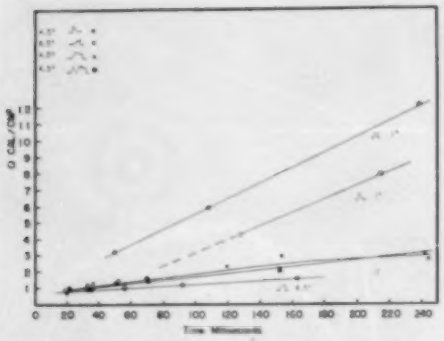

Fig. 10 (Ham, et al.). Threshold dose vs. time for various limiting apertures and pulse shapes.

for short exposure durations (20 to 35 ms). It is probable that at the high irradiances corresponding to short exposure times pulse shape has little influence upon the conduction of heat to the surrounding tissue; there is little time for conduction phenomena to take place regardless of how the energy is fed in as a function of time. On the other hand, at exposure times of 50 ms. or greater, pulse shape does seem to affect the rate at which energy is dissipated to the surrounding tissue. The shadow of the carbon arc holder which is present within all retinal images produced with a 4.5-inch diameter limiting aperture is an additional complication.

An attempt was made to study this phenomenon further by comparing square and triangular pulses at smaller image diameters on the retina where the shadow of the arc holder is not present. In Figure 10, two points for a sawtooth pulse producing a 0.24 mm. diameter image on the retina are plotted for comparison with equivalent square pulses. The opposite effect is noted; namely, the sawtooth pulse is significantly more efficient in producing a minimal lesion than the square pulse. It is unfortunate that more data on pulse shape thresholds at the smaller image diameters are not available since the effect of pulse shape seems to be more pronounced at these smaller image sizes and the direction of the effect is in keeping with former findings for flash burns on human volunteers.[7] However, the maximum irradiance available from the carbon arc is not sufficient to produce minimal lesions in less than 100 ms. exposure time because of the high thermal threshold and the necessary sacrifice of thermal energy for pulses other than square waves. We do not believe that the effect of pulse shape plays an important role for exposure times under 20 milliseconds in duration. The sudden input of energy, before conduction phenomena to surrounding tissue can play an effective role, raises the temperature to a level where irreversible changes (denaturation of protein, for example) take place; the manner in which irradiance varies with time (pulse shape) is unimportant for these short exposures.

Clinical and histologic description of burn lesions

The concept of a minimal lesion which developed during this investigation has focussed attention on mild vs. severe burns of the retina. For purposes of classification, the following distinctions between mild and severe lesions may be stated:

Severe burns

These are visible ophthalmoscopically immediately after exposure; they appear white, usually round or slightly oval, but no outline of the shadow from the arc holder can be distinguished in the larger burns; a small halo of lesser density and of an orange or yellowish hue appears around the lesion within the first few minutes after exposure; a slight vitreous haze overlying the lesion is usually observed for the first three or four days after exposure.

Mild burns

These are not visible immediately after exposure but require one to three minutes to develop; the color is yellowish or slightly orange, corresponding in appearance to the halo observed around severe burns; the shape is invariably "kidney bean" because

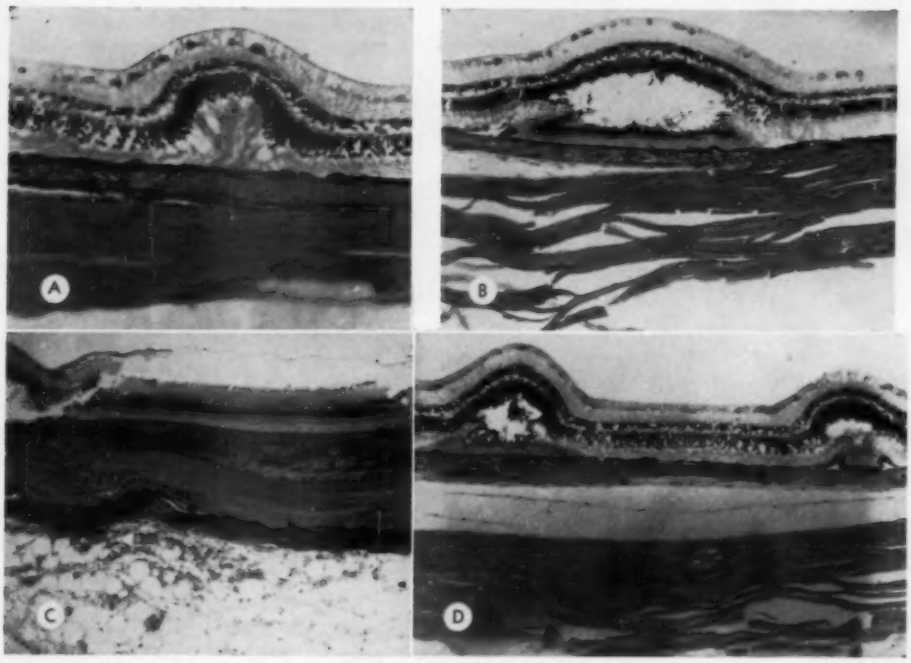

Fig. 11 (Ham, et al.). Histologic sections of retinal lesions. (A and B) Mild lesions. (C) Severe lesion. (D) Adjacent mild lesions.

of the shadow of the arc holder within the image on the retina; for small lesions not involving the shadow of the arc holder, the shape is round; no vitreous haze above the lesion is observable.

The clinical and histologic findings in the severe burns have been described previously.[8] This types of lesion which extends into the sclera has possible clinical application. Heat coagulation by this method has the same effect upon the retina and choroid as electrodiathermy and could be used therapeutically in most instances where the latter is indicated. Modifications of the apparatus can be made to facilitate a better localization of the image on the desired part of the retina. Weve[15] and Meyer-Schwickerath[16] have utilized this type of treatment recently in retinal detachment with central tears and in malignant tumors of the eye.

From two to three globes corresponding to each type of exposure producing mild lesions at various aperture sizes, delivery rates, and pulse shapes have been processed histologically.* Figure 2 illustrates the typical histologic appearance of the mild lesions (A, B) as contrasted to a severe (C) lesion which is included for comparison. Also shown are two adjacent mild lesions on the retina (D).

In the mild lesions, the appearance is as follows: in globes enucleated within the first few hours after the burn, the lesions

* Through the courtesy of Dr. A. B. Reese, Institute of Ophthalmology, Presbyterian Hospital, New York City, the globes were fixed and sent to Mr. Edward Gonzales for sectioning and staining.

are confined to the pigment epithelium and to the outer retinal layers; there is folding of the pigment epithelium and pyknosis of the nuclei of the epithelial cells; the structure of the rods and cones is lost completely, this layer appearing homogeneously red; in most instances, there is inward folding of the inner retinal layers because of disrupture of the outer nuclear layer and the rods and cones; the cell bodies are fragmented and the nuclei appear very dark and pyknotic in the outer nuclear layer; the normal architecture is grossly disarranged in this layer in contrast to the findings for severe lesions where necrosis but no observable disruption of the outer nuclear layer takes place; the inner nuclear layers, though folded, appear relatively normal, showing only an occasional pyknotic nucleus; the nerve fibers also appear normal or just slightly edematous; choroidal involvement was not observed during the acute phase except for some very questionable hyperemia; it is believed that the inward folding of the retina due to disrupture of the outer retinal layers is a distinct histologic characteristic of the mild lesion immediately following its production. The bulge into the vitreous is no longer observable in globes enucleated and fixed several days after burning. Healing takes place by proliferation from the pigment epithelium cells and from the pigment cells of the choroid, ultimately leaving a retinal scar with considerable thinning of the retina in the lesion area. From these observations it can be assumed that, although mild, these lesions lead to cessation of retinal function in the involved area because of destruction of the rods and cones. The mild lesion or threshold burn is therefore a suitable biologic criterion for threshold damage to the retina.

The histologic appearance of the mild lesion substantiates the findings of Byrnes, et al.,[4] in that absorption of thermal energy seems to take place almost wholly within the pigment epithelium and the pigment cells of the choroid. We are not aware of any investigation of burn threshold in the retina as a function of spectral quality of the radiation. In the absence of more detailed knowledge, it seems justified to assume that melanin plays an important role in thermal energy absorption since it is known to be the principal pigment substance present in the pigment epithelium and the choroid.[17] Judging by the percent reflectance vs. wavelength curve given by Hall, et al.,[18] it seems that melanin absorbs strongly throughout the range 400 to 700 millimicrons, reaching a peak at 400 millimicrons. The same authors give a reflectance curve for blood which indicates that it also absorbs strongly in the visible region of the spectrum. It is probable, therefore, that wavelengths in the visible region, 400 to 700 millimicrons, which also have a high transmission coefficient through the ocular media of the rabbit,[10] are mainly responsible for thermal injury to the retina. A study of the influence of spectral quality upon the production of retinal burns would provide valuable data which would be helpful in assessing the thermal radiation effects of the atomic fireball.

Discussion in relation to nuclear weapons

The thermal dose, Q_e, in cal./cm.^{2} incident on the cornea from an atomic fireball can be estimated by means of the equation

$$Q_e = \frac{E}{4\pi R^2} e^{-\alpha R} \qquad (3)$$

where E is the total thermal yield in calories from the weapon, R is the slant range in KM from the explosion, and α is a mean attenuation coefficient of the atmosphere for the thermal radiation emitted by the fireball.[14] E is taken generally to be approximately 6.7×10^{12} cal. for a nominal weapon (20 KT). It is assumed usually that the ratio of thermal yield to total yield does not vary greatly for weapons over a moderate range of KT's. An accurate estimate of α

is difficult but for the purposes of this discussion α will be taken as 0.1 km^{-1}; this amounts to an average mean free path for photons of 10 km. or 6.2 miles, corresponding to a clear atmosphere where the visibility is about 25 miles. It is important to emphasize that the exponential attenuation factor in equation (3) is peculiarly important to this discussion since only those photons which have not been scattered or absorbed can contribute to the image of a fireball on the retina. Scattered photons incident on the cornea would irradiate the entire fundus, contributing a negligible thermal dose to the area occupied by the image of the fireball. The thermal dose on the retina, Q_r, is given by

$$Q_r = \frac{Q_c \times D^2 \times 0.80}{d^2} \qquad (4)$$

where 0.80 is the average transmission coefficient through the ocular media of the rabbit eye for a black body at 5,800°K as determined from the data in reference 10 and D is the pupillary diameter. The diameter of the fireball image on the retina is

$$d = \frac{F}{R} \times (\text{focal length}) \qquad (5)$$

where F is the diameter of the fireball. F is a function of time after the detonation but the fireball of a nominal weapon (20 KT) increases in diameter rather slowly after the first phase and it is legitimate for this discussion to take an average value for F (780 ft. for a 20 KT yield) since the interest here is focussed on threshold effects at large distances R from the explosion where the possible effect of the first fireball phase upon the production of threshold lesions may be safely ignored for weapons of 100 KT or less. In the case of megaton weapons, the first phase of the fireball may occupy the entire period of the blink reflex and it might be necessary to take account of F as a function of time. Fireball diameters are proportional to the two-fifths power of the yields. Thus, if F is taken as 780 ft. in diameter for a 20 KT weapon, the diameter of a 100 KT fireball would be 780 ft. multiplied by the cube root of 5.0 or 1,480 ft.

Equations (3), (4), and (5) may be combined to give the total or integral retinal dose Q_r as a function of R for a given weapon

$$Q_r = \frac{Ee^{-\alpha R}}{AF^2} \qquad (6)$$

where

$$A = \frac{4\pi\ (\text{focal length})^2}{0.80 \times D^2} \qquad (7)$$

For a rabbit with equivalent focal length of one cm. and a pupil diameter of 0.8 cm., $A = 24.5$; in the human, the equivalent focal length may be taken as 1.7 cm. and $A = 71$ for a pupil diameter of 0.8 cm.

Figure 12 is a semilog plot of Q_r in cal./cm.^{2} for the rabbit vs. the slant range R

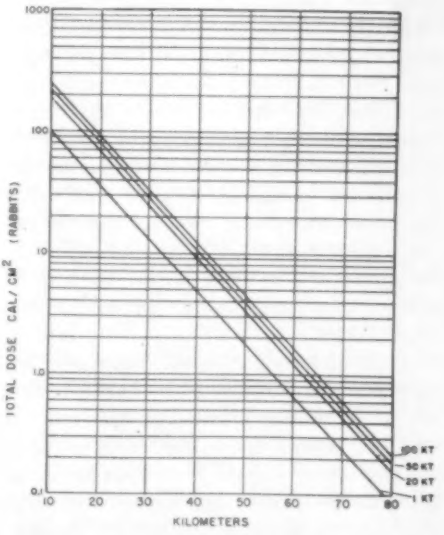

Fig. 12 (Ham, et al.). Total dose in cal./cm.^{2} to the rabbit retina vs. distance from bomb for several kilotonnages.

in km. for one, 20, 50, and 100 KT weapons. The pupillary diameter of the rabbit was taken as 0.8 cm and α was assigned a value of 0.1 km^{-1} corresponding to 25-mile visibility.

The thermal dose, Q_r, as given in Figure 12 represents the maximum integral dose delivered to the retina of the rabbit for infinite exposure time, regardless of pulse shape, or time of delivery. It is simply an idealization representing the maximum dose which the retina would receive in a very clear atmosphere if the pupillary diameter were 0.8 cm. corresponding to dark adaptation, and there was no blink reflex or other phenomenon to interfere with the delivery of the energy to the retina.

The purpose of calculating the retinal dose to the rabbit under maximal conditions for several weapon yields is to provide orders of magnitude as a basis for discussion of the various factors investigated in this report and to use these factors to estimate the distance from a weapon at which a threshold burn may be reasonably expected.

The constants used in arriving at Q_r by means of equation (6) are arbitrary and subject to reappraisal in terms of more detailed experimental data as it becomes available. For example, equation (6) can be used for a particular shot in Nevada where reasonably accurate estimates for E, F, and α may be known. However, a calorimetric determination of Q_c, the thermal dose to the cornea, must be made with a well-collimated calorimeter to exclude scattered radiation; otherwise, the reading would be high in relation to the dose which can be focussed on the retina.

As mentioned previously, Byrnes, et al.,[4] have reported "chorioretinal" burns in three out of 10 rabbits exposed at 42.5 miles or 68.4 km. from a bomb. Referring to Figure 12 and taking a 50 KT weapon as an approximation of this shot, the total dose, Q_r, to the retina would be roughly 0.7 $cal./cm.^2$ on the assumption that the rabbit did not blink. If it be assumed that all of this energy be delivered in 250 ms. (approximate value of blink reflex in rabbits) the average irradiance, ϕ_r, on the retina would be 2.8 $cal./cm.^2/sec.$ The diameter, d, of the image on the retina would be approximately 0.05 mm., assuming an average diameter for the fireball of 323 meters. Referring back to Figure 10 it is found that even for a diameter of 0.24 mm. on the retina, a rapidly rising sawtooth pulse must deliver a dose of 9.0 $cal./cm.^2$ to produce a minimal lesion in 250 ms.; this corresponds to an average irradiance of 36 $cal./cm.^2/sec.$ Furthermore, Figure 7 shows that for image diameters of 0.2 mm. and irradiances of 74 $cal./cm.^2/sec.$, the threshold dose is about 15 $cal./cm.^2$ for square waves; it was also found that irradiances of 70 $cal./cm.^2/sec.$ for exposure intervals of one second or more did not produce an observable lesion when the image diameter on the retina was 0.12 mm.

It would appear that the production of lesions at 42.5 miles is completely incompatible with the results of this investigation. However, it would be unsound to form such a conclusion because of the large effect exerted upon Q_r in equation (6) by the attenuation factor $e^{-\alpha R}$; α was taken as 0.1 $km.^{-1}$, visibility about 25 miles.

The atmosphere at the Nevada proving grounds is notoriously clear and if α be taken as 0.05 $km.^{-1}$, the retinal dose at 42.5 miles becomes 22 $cal./cm.^2$ and the irradiance 88 $cal./cm.^2/sec.$ on the assumption that the entire dose was delivered in 250 ms. It is quite possible that 20 to 30 percent of the dose was delivered within this time interval, so that Q_r might range from 4.4 to 6.6 $cal./cm.^2$ and the irradiance from 17.6 to 26.4 $cal./cm.^2/sec.$ This serves to emphasize the extreme criticality of dose calculations upon the atmospheric attenuation factor.

It is also worth pointing out that spectral quality will vary with distance since Rayleigh scattering preferentially removes the short wavelengths, and water vapor, if present, will remove the infrared. Atmospheric attenuation may be affected also by tem-

perature inversions and other phenomena. Transmission through the atmosphere is a complex problem dependent upon many variables and it is not possible to eliminate the probability of retinal burns at extreme distances under special circumstances. It can be said, however, that attenuation coefficients less than 0.1 km.$^{-1}$ are a rare occurrence in most parts of the world and it is extremely improbable that retinal burns in rabbits or man will occur at distances of 40 miles or more through the atmosphere.

In the absence of any experimental data it is permissible to adopt the hypothesis that the sensitivity of the human retina to thermal injury is the same as that of the rabbit. The remainder of this discussion will be devoted to this hypothesis with the additional assumption that the transmission coefficient through the ocular media for both rabbit and man may be taken as 0.80. If the equivalent focal length of the human eye be taken as 1.7 cm., equation (6) may be used to calculate the total dose, Q_r, to the human retina for various weapon yields. This has been done in Figure 13 where Q_r in cal./cm.^{2} is plotted against slant range R in km. for one, 20, 50, and 100 KT bombs. The sole difference between Figure 12 for rabbits and Figure 13 for humans is the equivalent focal length which makes the constant A (equation 7) 71 rather than 24.5.

Once again, the constants used in equation (6) are arbitrary and subject to revision in terms of available data. The authors have chosen a value for α of 0.1 km.$^{-1}$ (25-mile visibility) and a maximum dilation of the human pupil of 0.8 cm. in order to investigate the distance at which a human threshold burn might be expected to occur under fairly ideal conditions, namely, a clear atmosphere and complete dark adaptation. Values of Q_r for various pupillary diameters may be calculated by multiplying the values taken from Figure 13 by the ratio of the squares of the pupillary diameters. Thus, for a pupillary diameter of 0.3 cm., the total retinal dose Q_r would be reduced by a factor $(3)^2/(8)^2$ or 0.14.

The effect of pupillary diameter upon the sensitivity to retinal damage is obvious; what is not so obvious at first glance is the effect of d, the image diameter on the retina. It is generally considered that the rabbit eye is more sensitive to retinal damage at a given distance than the human eye because the energy incident on the rabbit retina will occupy a smaller area than the same energy on a human retina, thus producing a larger energy density or thermal dose. However, this investigation has demonstrated that the burn threshold depends markedly upon the retinal image diameter; this effect of image size together with the longer blink reflex in the rabbit tends to cancel out the differences in sensitivity between the two eyes.

The effect of image size upon burn threshold is more important than pulse shape or rate of energy delivery at large distances from a bomb. Figure 14 is a log-log plot for the human eye of retinal image diameter in mm. vs. slant range R in km. for weapon yields of one, 20, 50, and 100 KT. The assumption is made that fireball diameters are proportional to the two-fifths power of the yields, the average diameter of a 20 KT weapon being taken as 780 ft. or 238 meters. It should be noted that the fireball image diameter on the retina becomes 0.1 mm. for a 1.0 KT weapon at approximately 12 km., for a 20 KT weapon at 40 km., 50 KT at 58 km., and 100 KT at 76 km. With the irradiances available in the laboratory it was impossible to produce an observable lesion either ophthalmoscopically or histologically when the image diameter on the retina of the rabbit was 0.12 mm. or less. The inference is strong, therefore, that retinal damage will not occur in man unless it can be demonstrated that the bomb produces irradiances and thermal doses on the retina at these distances which are in excess of those produced in the laboratory. The above inference must be tempered somewhat by considerations of rate of energy delivery and the effects of pulse shape.

TABLE 6

THE THERMAL DOSE DELIVERED IN 150 MS. TO THE HUMAN RETINA FOR VARIOUS WEAPON YIELDS AND DISTANCES

Yield KT	R km.	d mm.	Q_r Cal./cm.^{2}	Q_r in 150 ms. Cal./cm.^{2}	Av. ϕ_r in 150 ms. Cal./cm.^{2}/sec.
1	24.2	0.05	8.7	6.5	43.3
1	15.1	0.08	21.0	15.8	105.0
1	12.2	0.10	28.0	21.0	140.0
20	27.0	0.15	12.0	3.4	22.7
20	20.2	0.20	23.0	6.5	43.3
20	16.1	0.25	34.0	9.7	64.7
50	23.3	0.25	20.0	3.0	20.0
50	19.4	0.30	30.0	4.6	30.7
50	16.7	0.35	40.0	6.1	40.7
100	25.5	0.30	19.0	2.3	15.3
100	21.8	0.35	27.5	3.3	22.0
100	19.9	0.40	35.0	4.2	28.0

The blink reflex (approximately 100 ms.) provides man with an additional factor of safety. Making allowances for biologic variation, it is conservative to take 150 ms. as the exposure interval to an atomic fireball. The fraction of the total thermal dose delivered within a specified time interval after detonation is known; it will vary with the weapon yield, being larger for the smaller weapons. This phenomenon makes the small weapons hazardous to the eye in spite of their relatively low yield of thermal energy. The sharp pulse front in the small weapon also contributes to the retinal hazard.

Table 6 has been compiled with the above factors in mind. The retinal image diameter of the fireball has been taken from Figure 14, and is given in column 3; the total thermal dose, taken from Figure 13, is given in column 4; the fraction of this thermal dose delivered in 150 ms. is estimated in column 5; and the average irradiance during the first 150 ms., based upon this estimate, is given in column 6.

The retinal threshold dose at 150 ms. for rabbits exposed to a sharp front, sawtooth pulse is approximately 5.4 cal./cm.^{2} for an image diameter of 0.24 mm. as taken from Figure 10. It is extremely unfortunate that thresholds for smaller image diameters with pulses could not be obtained because of the limitations of the carbon arc. The average irradiance for this pulse is 36 cal./cm.^{2}/sec. and the peak irradiance is 61 cal./cm.^{2}/sec.

The 1.0 KT weapon at a distance of 15.1 km. delivers 15.8 cal./cm.^{2} to the retina in 150 ms., as taken from Table 6; when the small image size is taken into account, it is doubtful whether this dose would produce a minimal lesion. However, the average irradiance is 105 cal./cm.^{2}/sec. and it seems wise to assume that the 1.0 KT weapon would produce a minimal lesion at 15.1 km.

Going to the 20 KT weapon, the image diameter is 0.2 mm. at 20.2 km. where the thermal dose is estimated to be 6.5 cal./cm.^{2} during the first 150 ms. This is close enough

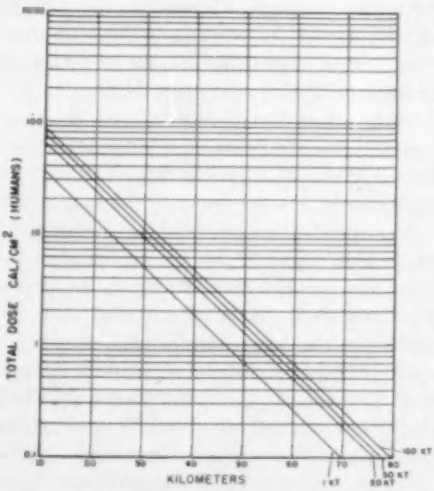

Fig. 13 (Ham, et al.). Total dose in cal./cm.^{2} to the human retina vs. distance from bomb for several kilotonnages.

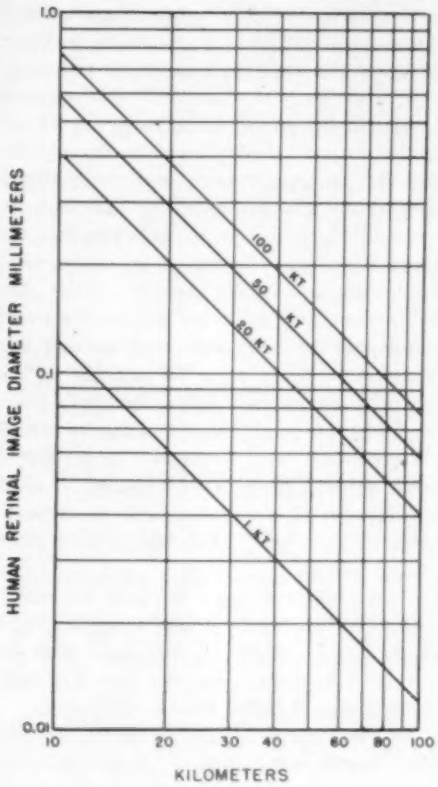

Fig. 14 (Ham, et al.). Human retinal image diameter vs. distance from the bomb for several kilotonnages.

to the laboratory data on rabbits to assume that a threshold lesion would be produced at 20.2 km.

For the 50 KT weapon, a dose of 4.6 cal./cm.^{2} in 150 ms. at an image diameter of 0.3 mm. should produce a minimal lesion according to the data on rabbits. Threshold effect for the 50 KT weapon is estimated, therefore, to occur at 19 to 22 km.

The 100 KT weapon produces 3.3 cal./cm.^{2} with an average irradiance of 22 cal./cm.^{2} sec. at 21.8 km. However, the image diameter is about 0.35 mm. at this distance so that the threshold would be somewhat lower than for the rabbit at an image diameter of 0.24 mm. It may be assumed, therefore, that a minimal lesion would be produced at about 21.8 km. from the 100 KT weapon.

It is somewhat startling at first to realize that all these estimates for threshold effect in weapons ranging in yield from 1.0 KT to 100 KT occur within a slant range of 15 to 22 km. Several factors are compensating for each other; a little introspection reveals that small weapons because of their high rate of delivery and small fireball diameter are approximately equivalent to the larger weapons with their high thermal yield with large fireball diameter but relatively slow rate of delivery. The blink reflex comes to the rescue for the larger weapons. Pulse shape should not play a major role at these distances. It is concluded that the human eye would receive a minimal burn at approximately nine to fourteen miles from weapons ranging in yield from 1.0 to 100 KT if the following factors prevailed: dark adaptation, 0.8 cm. pupillary diameter; clear atmosphere, mean free path 6.2 miles, visibility 25 miles; blink reflex operating in 150 ms. to exclude further irradiance from the bomb.

When it is considered that for a normally clear day in most parts of the world visibility is about 12 miles ($\alpha = 0.2$ km.$^{-1}$), while the visibility around cities is perhaps six miles ($\alpha = 0.4$ km.$^{-1}$), it can be appreciated that the distance between ground zero and where a threshold lesion would occur is not too large. It must be remembered, however, that as the attenuation factor reduces the distance at which appreciable thermal energy is delivered, the image size of the fireball increases, so that the burn threshold is lowered. The normal pupillary diameter of the human eye rarely exceeds 4.0 to 6.0 mm. so that an additional factor of safety of 0.25 to 0.56 is present. Furthermore, the probability that the victim is focussed on the fireball at the moment of dentonation is not high. Other factors of safety reside in the fact that central vision will not be destroyed unless the burn occurs within the macular

region. Small lesions of 0.2 to 0.5 mm. diameter on other regions of the fundus are not unduly damaging to vision unless retinal detachment develops. All factors considered, we do not believe that the retinal hazard on the ground is appreciable except for personnel using optical instruments or performing observational duties at night.

Weapons detonated at high altitude present an entirely different problem. Here, the attenuation factor $e^{-\alpha R}$ in equation (6) would be small or negligible; thermal doses and irradiances of a magnitude which cannot be produced in the laboratory would be incident over distances limited only by the curvature of the earth. The blink reflex and the diminution in image size would be the only natural protective factors. It is a matter of pure conjecture as to what the effect on the retina would be for thermal doses of several hundred cal./cm.^{2} concentrated on very small areas of the retina. For personnel on the ground subjected to a high altitude fireball, the attenuation factor must include a gradient effect for air density as a function of height.

Summary

1. The effect of retinal image size is more important than pulse shape or rate of energy delivery in producing retinal burns at moderate distances from nuclear weapons.

2. It is estimated that the human retina would receive a threshold lesion at nine to 14 miles from nuclear weapons ranging in yield from 1.0 to 100 KT if atmospheric visibility were 25 miles, maximum dark adaptation prevailed (pupillary diameter 8.0 mm.), and the blink reflex excluded all thermal radiation after the first 150 milliseconds.

3. The size of thermal lesions on the retina depends upon exposure time and it is necessary to know the size of the retinal image before thermal dose to the retina can be calculated.

4. It is suggested that the dependence of burn threshold upon image size is a conduction phenomenon which can be understood qualitatively, at least, in terms of the temperature gradients induced on the retina.

5. The thermal threshold for minimal lesions in the rabbit retina ranges from 1.0 to 15 cal./cm.^{2} depending upon image size, rate of energy delivery, and pulse shape.

6. Histologic evidence for minimal lesions in the rabbit retina indicates that the thermal energy is absorbed in the pigment epithelium and in the pigment of the choroid, disrupting the outer nuclear layer and destroying the rods and cones without any appreciable effect upon the choroid or the sclera; these minimal lesions display a characteristic bulging into the vitreous which distinguishes them from the more severe burn lesions; the yellowish-orange color of the minimal lesion corresponds in appearance to the "halo" observed around more severe lesions.

7. A "hit or miss," "burn or no burn," technique has been evolved which is suited to statistical analysis by the probit method; precision in determining the burn threshold is estimated at better than $\pm$ 10 percent.

8. The optical system constructed to produce burns on the rabbit retina is applicable, with minor improvements, to clinical treatment of retinal detachment and tumors of the retina.

9. A method of photographing the burn lesion during production has led to a better understanding of the pathogenesis of thermal injury to the retina.

10. No major differences in burn threshold were detectable for different pulse shapes within the range of irradiances produced by the high intensity carbon arc where the image diameter on the retina was 1.0 mm. or greater; the data do indicate that for exposure times of 20 ms. or less the burn threshold does not depend upon pulse shape. For small image diameters (0.5 mm. or less) pulse shape is important for exposure times of 50 ms. or more.

11. The failure of reciprocity in producing threshold burns was investigated for

irradiances ranging from 70 cal./cm.²/sec. to 12 cal./cm.²/sec. and for exposure times ranging from 20 milliseconds to 250 milliseconds.

12. The effect of spectral quality upon the production of retinal burns was not investigated but it seems likely that visible light is more effective than the infrared in producing retinal lesions.

13. The coefficient of transmission of light through the ocular media of the rabbit was determined for the range 380 to 1,350 millimicrons and found to be 0.78 for the spectrum emitted by the carbon arc and 0.80 for the spectrum of a black body at 5,800°K.

14. The retinal hazard from nuclear weapons is not considered to be of major importance for personnel on the ground.

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References

1. Verhoeff, F. H., Bell, L., and Walker, C. B.: The pathological effects of radiant energy on the eye. Proc. Am. Acad. Arts & Sci., **51**:630, 1916.
Cogan, D. G.: Lesions of the eye from radiant energy. J.A.M.A., **142**:145-151, 1950.
2. Buettner, K., and Rose, H. W.: Eye hazards from an atomic bomb. Sight-Saving Review, **23**:1, 1953.
3. Oyama, A., and Sasaki, T.: A case of burn of the cornea and retina by atomic bomb. Ganya Rinsho Iho, **40**:177, 1946.
4. Byrnes, V. A., Brown, D. V. L., Rose, H. W., and Cibis, P. A.: Chorioretinal lesions due to thermal radiation from the atomic bomb. Arch. Ophth., **55**:909-914 (June) 1956.
5. Rose, H. W., Brown, D. V. L., Byrnes, V. A., and Cibis, P. A.: Human chorioretinal burns from atomic fireballs. Arch. Ophth., **55**:205 (Feb.) 1956.
6. Schmidt, F. H., Williams, R. C., Ham, W. T., Jr., Brooks, J. W., and Evans, E. I.: Experimental production of flash burns. Surgery, **36**:1163, 1954.
7. Evans, E. I., Brooks, J. W., Schmidt, F. H., Williams, R. C., and Ham, W. T., Jr.: Flash burn studies on human volunteers. Surgery, **37**:280, 1955.
8. Ham, W. T., Jr., Wiesinger, H., Guerry, DuPont, III, Schmidt, F. H., Williams, R. C., Ruffin, R. S., and Shaffer, M. C.: Experimental production of flash burns in the rabbit retina. Am. J. Ophth., **43**:711 (May) 1957.
9. Ham, W. T., Jr. and Trout, E. D.: Million volt beryllium window X-ray equipment for biophysical and biochemical research. Radiol., **55**:257 (Aug.) 1950.
10. Wiesinger, H., Schmidt, F. H., Williams, R. C., Tiller, C. O., Ruffin, R. S., Guerry, D., and Ham, W. T., Jr.: The transmission of light through the ocular media of the rabbit eye. Am. J. Ophth., **42**:907 (Dec.) 1956.
11. Henriques, F. C.: Studies of thermal injury. V. The predictability and the significance of thermally induced rate processes leading to irreversible epidermal injury. Arch. Path., **43**:489-502, 1947.
12. Fugitt, C. H.: A rate process theory of thermal injury. Armed Forces Special Weapons Project, AFSPW—606, December, 1955.
13. Mixter, G.: The empirical relation between time and intensity of applied thermal energy in production of 2+ burns in pigs. Univ. Rochester AEC Report UR-316, March, 1954.
14. The effects of atomic weapons. Gov. Printing Office, June 1950. N. B. A more modern and extensive version of this book is now available, July, 1957.
15. Weve, H. J. M.: Personal communication to one of authors.
16. Meyer-Schwickerath, G.: Photocoagulation of the retina. Ann. Ocul.: **189**:532-549, 1956.
17. Duke-Elder, S.: Textbook of Ophthalmology. St. Louis, Mosby, 1938, v. 1.
18. Hall, T. C., McCracken, B. H., and Thorn, G. W.: Skin pigmentation in relation to adrenal cortical function. J. Clin. Endocrinol. & Metabol., **13**:243, 1953.

EVALUATION AND USE OF OXIMES IN OPHTHALMOLOGY*

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The oximes and hydroxamic acids came into view recently as a result of a search for antidotes to alkyl phosphates. To the latter, the most potent chemical warfare gases and some powerful insecticides belong. Since these, like di-isopropyl fluorophospate (DFP), are irreversible cholinesterase inhibitors, they owe their lethality to the effect of accumulated acetylcholine in the body.[1]

Oximes and hydroxamic acid derivatives were found to be specific antidotes to alkyl phosphate poisoning in animals.[2] More recently, Grob and Johns found the oximes to be useful in the treatment of intoxication resulting from the overtreatment of myasthenia gravis patients with antichlorinesterases.[3]

The present investigation was carried out in an attempt to evaluate these compounds for possible use in ophthalmology.

MATERIALS AND METHODS

Pyridine-2-aldoxime methiodide (2-PAM), diacetyl monoxime (DAM), 1,1-trimethylenebis (4-formylpyridinium oxime bromide), (TMB-4), and monoisonitrosoacetone (MINA) were obtained in the powder or crystal form.†

These compounds were tested by their instillation into the conjunctival sac as a 1.0, 3.0, 5.0-percent aqueous solution, 5.0-percent aqueous solution with 1/3,000 zephiran chloride, and 5.0, 10, and 20 percent in vaseline as ointment.

The tests were carried out on 65 albino and three pigmented rabbits, each weighing two to three kg., and on 31 patients, white and Negro, at the Wills Eye Hospital. Tests were carried out on only those patients' eyes that had no intraocular pathology. Few exceptions are those eyes with uveitis and posterior synechias to be described later.

2-PAM was used more often than the other compounds in this work because more is known about this drug in other fields, and because the supply available for this investigation was greater.

The size of the pupil in a room of constant light intensity was used as the main criterion for judging the action of the oximes in the eye, whether used alone or in combination with other drugs. Rabbits' eyes were observed for a period of six to nine hours, and human eyes for 24 hours. The pupil of the fellow eye was used as control throughout the majority of these experiments.

FINDINGS AND OBSERVATIONS

The oximes, when instilled alone into the conjunctival sac of rabbits and humans, produced no observable effect on the size of the pupil.

Following a miosis produced by the local instillation of 0.10-percent DFP or 0.25-percent eserine salicylate into a rabbit's conjunctival sac, the pupil returns to about normal size in five to six hours after the instillation of an oxime (fig. 1A).

All four oximes used in this work were about equally effective in counteracting the action of DFP and eserine in the eye.

It appears that the penetration of the oximes into the eye following instillation into the conjunctival sac is poor in rabbits and humans, but much more so in the latter. A 1.0-percent solution of an oxime instilled into a rabbit's eye once every 10 minutes for

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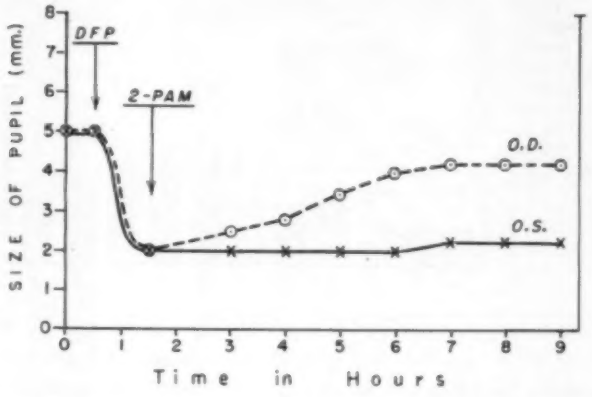

Fig. 1A (Mamo and Leopold). Di-isopropyl fluorophosphate (DFP) 0.10 percent in peanut oil, once 0.2. 2-PAM 1.0 percent in water every 10 minutes for six times. (O.D., rabbit.)

six times was far more effective than a single instillation of a 5.0-percent solution. With a few exceptions, the use of oximes in solution form for local instillation into human eyes was ineffective, regardless of the strength or frequency of instillation. The addition of a detergent, zephiran chloride 1/3,000, to these solutions caused no observable increase in the effectiveness of these drugs in rabbits or humans.

The use of these compounds in an ointment form (5.0, 10, and 20 percent in vaseline) proved to be more effective than in solutions in rabbits' eyes. The 10-percent and 20-percent ointment were effective in about 50 percent of human eyes tested.

The subconjunctival injection of a five-percent aqueous solution of an oxime proved to be 100-percent effective in rabbits and humans. Furthermore, its action started much earlier—in about one-half to one hour. However, the most effective, most reliable, and fastest acting of all methods tested was the intracameral. The action by this method can be observed to begin within a few minutes after the injection.

The oximes were just as effective after the use of eserine salicylate as they were

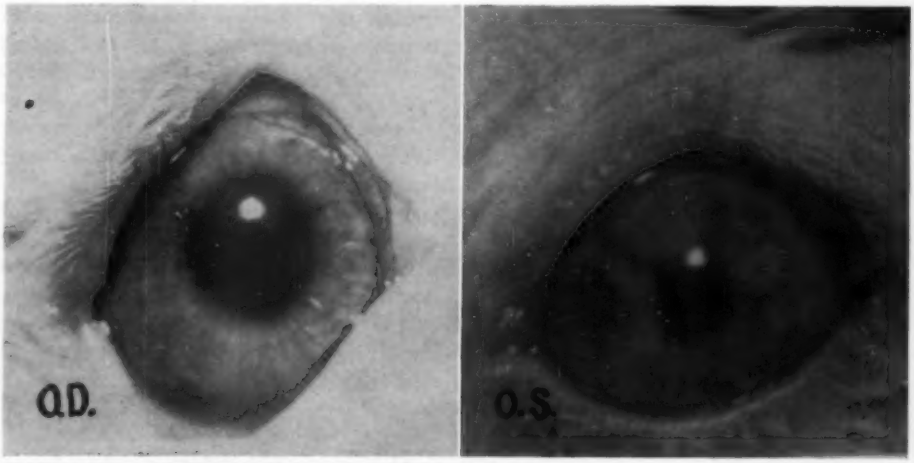

Fig. 1B (Mamo and Leopold). O.D., pupil of rabbit after DFP followed by 2-PAM. O.S., pupil of rabbit after DFP alone.

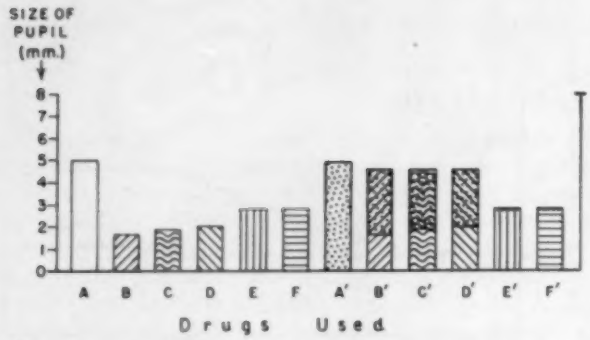

Fig. 2 (Mamo and Leopold). Variations in rabbit pupil size under constant illumination as influenced by 2-PAM. (A) Normal size of pupil. (B) Size of pupil after 0.10-percent DFP. (C) Size of pupil after 0.25-percent phospholine iodide. (D) Size of pupil after 0.25-percent physostigmine salicylate. (E) Size of pupil after 2.0-percent pilocarpine nitrate. (F) Size of pupil after 20-percent mecholyl chloride. (A′ to F′) Size of pupil after 2-PAM added to above-described eyes.

after the use of di-isopropyl fluorophosphate, in rabbit and human eyes. However, there was no observable effect when used after 2.0-percent pilocarpine nitrate or 20-percent mecholyl chloride in such eyes (fig. 2). Results with 2-PAM after phospholine iodide were similar to those after DFP in rabbits' eyes. 2-PAM was effective in overcoming phospholine iodide and DFP pupillary effect when injected a few minutes to five hours after instillation of the anticholinesterase agents.

When an oxime is instilled into the conjunctival sac of a rabbit following DFP or eserine, the pupil returns to almost normal size (fig. 1B). Under similar conditions, but given subconjunctivally, there is even more mydriasis. The latter two situations apply to human eyes also.

Following the instillation of 0.10-percent DFP in peanut oil into the conjunctival sac of a rabbit or a human, the instillation of 0.25-percent atropine sulfate drops caused a greater counteraction of the resulting miosis than the similar use of 10-percent oxime in ointment form. On the other hand, a subconjunctival injection of a 5.0-percent solution of an oxime was more effective in this respect than the local instillation of 0.25-percent atropine drops. This may be due to the greater and more rapid penetration of atropine into the anterior chamber, as compared to the oximes, when both are applied topically.

When used intracamerally after DFP, 2-PAM appears to be equal to, or possibly slightly more effective than, intracameral atropine in relieving the miosis.

A marked degree of mydriasis is produced when atropine 0.25-percent solution is instilled into the conjuntival sac following the local instillation of 0.10-percent DFP and a subconjunctival injection of 5.0-percent 2-PAM. A greater mydriasis is obtained if 10-percent neosynephrine, instead of 0.25-percent atropine, is similarly used. However, an extreme degree of mydriasis results when both atropine and neosynephrine are used in a similar way. This appears slightly greater than the mydriasis obtained by the use of atropine and neosynephrine without the prior use of DFP and 2-PAM (fig. 3). It may be due to the fresh release of reactivated cholinesterase which ties up more acetylcholine, thus adding further to the relaxation of the iris sphincter.

In an attempt to produce a rise in ocular tension secondary to the use of a strong cholinesterase inhibitor, 1.0-percent phospholine iodide was instilled into the conjunctival sacs of seven rabbits and a tension of 42 mm. Hg was obtained in one eye of one rabbit. Twenty minutes after a subconjunctival injection of 5.0-percent 2-PAM, the tension in that eye came down to 29 mm. Hg.

Mode of action

The protective action of the oximes against the lethal effects of aklyl phosphate poisoning in animals has been attributed to

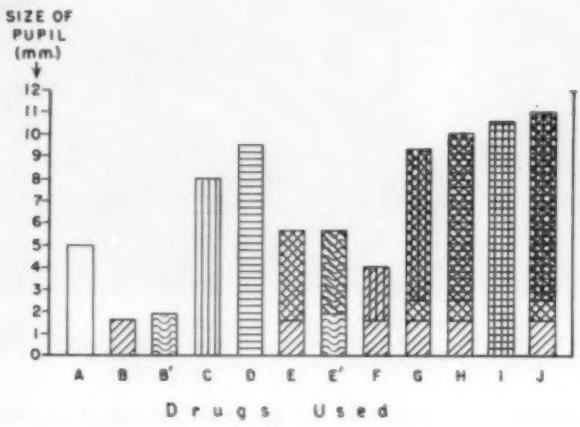

Fig. 3 (Mamo and Leopold). Variations in pupil size produced by combinations of drugs with 2-PAM. (A) Normal size of pupil, rabbit. (B) Size of pupil after 0.10-percent DFP. (B′) Size of pupil after 0.25-percent phospholine iodide. (C) Size of pupil after 1.0-percent atropine sulfate. (D) Size of pupil after 10-percent neosynephrine. (E) Size of pupil after DFP plus 5.0-percent 2-PAM subconjunctivally. (E′) Size of pupil after phospholine iodide plus 5.0-percent 2-PAM subconjunctivally. (F) Size of pupil after DFP plus atropine. (G) Size of pupil after DFP plus 2-PAM plus atropine. (H) Size of pupil after DFP plus 2-PAM plus neosynephrine. (I) Size of pupil after atropine plus neosynephrine. (J) Size of pupil after DFP plus 2-PAM plus atropine plus neosynephrine.

one or both of the following: (a) a direct reactivation of the irreversibly inhibited choline esterase, or (b) a direct combination between the oxime and the anticholinesterase agent in the body before the latter has reacted with the enzyme. These mechanisms may be inadequate to explain the rapid antidotal effect because of the slow rate of reactivation of cholinesterase by PAM and the slow rate of reaction between PAM and the inhibitor.

That the oximes do not have an atropine-like action was demonstrated by Kewitz, et al.[4] They found that the effect of acetylcholine on the blood pressure of eviscerated cats was neither abolished nor diminished by 2-PAM, even when large doses were used; while it was completely abolished by a small dose of atropine.

Available evidence indicates that, at least partially, the action of the oximes is a reactivation of cholinesterase. The work of Kewitz[5] on the diaphragmatic muscle of mice and that of Koelle[6] on the ciliary and stellate ganglia and the intercostal muscles of cats support this theory.

The present work also adds further evidence that the oximes do reactivate DFP-inhibited cholinesterase. After a miosis produced by the instillation of DFP into the conjunctival sac of a rabbit's eye, a thorough irrigation of the anterior chamber with distilled water will produce a slight increase in the size of the pupil, and this remains stationary for quite some time. This may be due to the washing out of the excess DFP present in the aqueous, to the hypotony that resulted from the paracentesis, or to both. However, when, instead of distilled water, the same procedure is carried with a 5.0-percent 2-PAM solution, the pupil dilates more and the dilatation is rapid and progressive (fig. 4).

Cholinesterase is an enzyme with two active sites: an ester interacting site and an anionic site, both of which are necessary for its activity.

When the esteratic site reacts with esters, an acetyl enzyme is formed. The latter hydrolyses rapidly with water, yielding an active enzyme whose anionic site is free and can bind acetylcholine. The activity of the enzyme is attributed to the speed of this hydrolysis.[7]

In the presence of alkyl phosphates, a phosphoryl enzyme is formed instead of an acetyl one, and, unlike the latter, it does not react readily with water. It is the slowness of this reaction which makes these compounds inhibitors. Although its anionic site

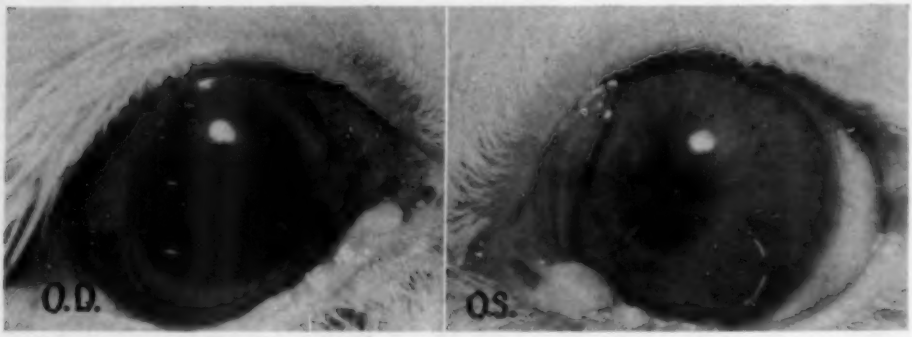

Fig. 4 (Mamo and Leopold). O.D., pupil of an albino rabbit after local instillation of 0.10-percent DFP followed by 5.0-percent 2-PAM intracamerally. O.S., pupil after instillation of 0.10-percent DEP followed by 0.25-percent atropine sulfate intracamerally.

is still capable of binding structures like acetylcholine, it is only one-sixtieth of that in the normal enzyme.[7]

Whereas reversal of inhibition by alkyl phosphates is very slow with water, it was found that it can be accomplished more readily with nucleophilic agents such as choline and more particularly hydroxylamine. It was later shown that the hydroxamic acids, and even much more so the oximes, were considerably more effective reactivating agents.[8] However, the mechanism of reactivation does not appear to be thoroughly understood at present.

Although the oximes can reactivate organophosphorus-inhibited cholinesterase, Grob and Johns[9] have demonstrated that they can also reactivate quarternary ammonium-inhibited enzymes like prostigmin. Similar results were obtained in this investigation with eserine. This seems to contradict the findings of Kewitz, et al.,[4] who found no protection whatsoever by 2-PAM to mice injected subcutaneously with a lethal dose of eserine sulfate.

Toxicity and other properties

When given to animals, the breakdown of oximes in the body is probably a hydrolysis to hydroxylamine or enzymatic reduction to amine. The breakdown of MINA, however, results in the formation of hydrogen cyanide; and rats given high doses of this oxime die with signs of HCN poisoning.[9] The other oximes appear to be less toxic, and signs of poisoning in rats are marked lethargy, musclar tremors, and loss of reflexes.[10]

In the eye, only when a concentration of 10 percent of an oxime in ointment form was used did patients complain of burning sensation in the eye, and conjunctival hyperemia developed. Signs and symptoms were more severe with a 20-percent ointment, and one patient developed a membranous conjunctivitis that took about 10 days to clear.

No side-effects were observed from the use of a 5.0-percent aqueous solution of an oxime subconjunctivally or intracamerally in rabbits or humans.

Also no sensitivity or allergic reactions were encountered in this study.

All four oximes tested appear to be unstable in solution form, but MINA is unstable even in the solid form. By comparing the activity of fresh solutions of all four oximes with that of three-month-old ones at room temperature, it was found that these oximes lose at least 25 percent of their effective power during that period.

Because of its toxicity as well as its instability, MINA was not tested on human eyes (table 1).

A 5.0-percent solution of 2-PAM appears to be close to the saturation limit. If kept in

TABLE 1

DIFFERENT OXIMES USED AND METHOD OF INSTILLATION IN RABBIT AND HUMAN EYES

Oxime		Solution Local	Solution Local +Detergent	Ointment Local	Subconjunctival	Intracameral	Total
2-PAM							
	Rabbit	21	1	2	10	11	45
	Human	2	2	10	7	1	22
DAM							
	Rabbit	9	0	0	0	0	0
	Human	1	1	1	1	0	4
TMB-4							
	Rabbit	3	0	0	1	0	4
	Human	1	1	3	0	0	5
MINA							
	Rabbit	10	0	0	0	0	10
	Human	0	0	0	0	0	0
							99

a cool place a crystalline precipitate forms, and the latter redissolves rather slowly on warming and shaking.

USE IN OPHTHALMOLOGY

As a result of this investigation, it appears that the oximes may offer their best use in ophthalmology in the following:

1. *As antidotes to DFP.* This drug, from the numerous reports in the literature and from its wide use among ophthalmologists today, appears to have established a place for itself in ophthalmology.[11] Its ocular effects, miosis, cyclotonia, far outlast those produced by other previously known miotics.[12] Also being a very powerful drug, some undesirable side-effects and complications have occasionally resulted from its use. Phospholine iodide has similar activity.[17]

Among the most common side-effects from DFP are: browache, muscular twitching of the eyelids, ocular pain, headache, photophobia, blurring of vision (induced myopia), and allergic reactions. More serious complications, such as retinal detachment, are known to occur.[13] A rise instead of a fall in intraocular pressure may result from the use of this drug. Stone[14] reported 24 out of 150 cases, or 16 percent of the patients treated with DFP, that had a secondary rise in tension due to the use of the drug.

A 5.0-percent solution of PAM may be injected subconjunctivally as an effective and rapidly acting antidote (one to two hours) in these circumstances.

2. *To free posterior synechias and iris prolapse.* In cases of uveitis or iritis with posterior synechias, a method known for some time for freeing these synechias has been the alternate use of miotics and mydriatics. However, this method has been limited in its usefulness because only the weaker miotics and mydriatics could be used, since it was difficult to overcome the action of stronger ones. Furthermore, the process could not be repeated when the stronger drugs were used.

The use of the oximes in these cases will eliminate many of these obstacles. A miotic as strong as DFP or phospholine iodide can be used. Later a 5.0-percent aqueous solution of PAM given subconjunctivally will eliminate the effect of DFP in a couple of hours. The subsequent instillation of 1.0-percent atropine and 10-percent neosynephrine may produce a greater mydriatic effect than if these drugs were instilled without prior use of DFP and PAM (fig. 3). This is probably due to three forces responsible for the relaxation of the iris

sphincter instead of the usual two; namely (a) the fresh release by PAM of reactivated cholinesterase which hydrolyzes more acetylcholine, (b) the inhibition of acetylcholine action on the sphincter by atropine, and (c) the stimulation of the dilator fibers by neosynephrine.[18]

Furthermore, if the process is not successful the first time, it can be repeated. DFP can overcome the effects of atropine and neosynephrine on the pupil.[18]

This theoretic method was applied to two patients with uveitis, one having both eyes involved. The uveitis was advanced and of long standing in all three eyes and the synechias were very dense. Only partial easing off of the adhesions was obtained, not enough to be of any significant help. However, this procedure did accomplish more than previous employment of cycloplegics and adrenergic agents.

3. *To obtain extreme dilatation of the pupil,* as shown in Figure 3. The mydriasis produced by atropine and neosynephrine after the use of DFP and PAM appears to be slightly greater than that obtained by the use of these drugs alone. This may not be significant but might be due, as described above, to the fresh release of reactivated cholinesterase which in turn hydrolyzes more acetylcholine, thus adding further to the relaxation of the sphincter.

For this purpose, the oxime (5.0-percent 2-PAM in aqueous) should be used subconjunctivally after DFP.

Such a method may be tried whenever an extreme degree of mydriasis is desirable for diagnostic work or surgical procedures.

With the mydriasis, there is probably an associated cycloplegia.

4. *To counteract the systemic effects of anticholinesterase drugs used in ophthalmology.* Rare and mild systemic effects do occur when high concentrations of anticholinesterase agents are used frequently in the eye. When 2.0-percent phospholine iodide was instilled into both eyes of three rabbits they developed marked salivation, respiratory failure, and death within 15 minutes. Three rabbits similarly treated with 2.0-percent phospholine iodide were resuscitated when given 3.0 ml. of 5.0-percent PAM intravenously 10 minutes after the drop instillation. Similarly the overuse of anticholinesterase agents for the diagnosis or treatment of myasthenia gravis does occasionally result in intoxication.[19] Atropine in these cases gives symptomatic relief, but does not protect against muscular weakness which is responsible for causing death in these cases, unless artificial respiration and open airway are employed. The treatment of such cases by the intravenous use of oximes, described by Grob and Johns[8, 18, 19] could be of value to ophthalmologists.

Summary

An evaluation of four oxime compounds —2-PAM, DAM, TMB-4, and MINA— for use in ophthalmology has been made.

The mode of administration, doses, toxicity, and other properties were determined.

The main uses in ophthalmology were found to be:

1. As antidotes to DFP and phospholine iodide when side-effects or complications result from their use in the eye.

2. To free posterior synechias and iris prolapses in cases of uveitis, trauma, or surgery when used after anticholinesterase miotics and before mydriatics.

3. To obtain extreme dilatation of the pupil for diagnostic or surgical work.

4. To treat systemic effects of anticholinesterase agents used in the eye, or accidentally exposed to, or the overuse of these agents in the diagnosis and treatment of myasthenia gravis.

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References

1. Wilson, I. B., and Meislich, E. K.: Reactivation of acetylcholinesterase inhibited by alkyl phosphates. J. Am. Chem. Soc., **75**:4628-4629, 1953.

2. Askew, B. M.: Oximes and hydroxamine acids as antidotes in anticholinesterase poisoning. Brit. J. Pharmacol., **11**:4717-423, 1956.
3. Grob, D., and Johns, R. J.: Treatment of anticholinesterase intoxication with oximes. J.A.M.A., **166**:1855-1858, 1958.
4. Kewitz, H., Wilson, I. B., and Nochmansohn, D.: A specific antidote against lethal alkyl phosphate intoxication. II. Antidotal properties. Arch. Biochem. & Biophys., **64**:456-465, 1956.
5. Kewitz, H.: A specific antidote against lethal alkyl phosphate intoxication. III. Repair of chemical lesion. Arch. Biochem. & Biophy., **66**:263-270, 1957.
6. Koelle, G. B.: Histochemical demonstration and reactivation of acetylcholinesterase in vivo. Science, **125**:1195-1196, 1957.
7. Wilson, I. B., Ginsberg, S., and Meislich, E. K.: The reactivation of acetyl cholinesterase inhibited by tetraethyl pryophosphate and di-isopropyl fluorophosphate. J. Am. Chem. Soc., **77**:4286-4291, 1955.
8. Childs, A. F., Davies, D. R., Green, A. L., and Rutland, J. P.: The reactivation by oximes and hydroxamine acids of cholinesterase inhibited by organophosphorus compounds. Brit. J. Pharmacol., **10**: 462-46, 1955.
9. Askew, B. M., Davies, D. R., Green, A. L., and Holmes, R.: The nature of the toxicity of 2-oxo-oximes. Brit. J. Pharmacol., **11**:424-427, 1956.
10. Askew, B. M.: Oximes and hydroxamine acids as antidotes in anticholinesterase poisoning. Brit. J. Pharmacol., **11**:417-423, 1956.
11. Callahan, A.: Use of di-isopropyl fluorophosphate in 0.01 percent and 0.025 percent concentrations. Am. J. Ophth., **43**:281-283 (Nov., Pt. II), 1957.
12. Leopold, I. H., and Comroe, J. H., Jr.: Effect of di-isopropyl fluorophosphate (DFP) on the normal eye. Arch. Ophth., **36**:17-32, 1946.
13. Westsmith, R. A., and Abernathy, R. E.: Detachment of retina with use of di-isopropyl fluorophosphate in treatment of glaucoma. Arch. Ophth., **52**:779-780, 1954.
14. Stone, W.: Use of di-isopropyl fluorophosphate (DFP) in treatment of glaucoma. Arch. Ophth., **43**:36-42, 1950.
15. Boros, B., and Takats, I.: Die Frage der Doppelinnervation des Sphincterirides im Lichte des Cannonschen Denervationsgesetzes. Arch. f. Ophth., **152**:319-334, 1952.
16. Leopold, I. H., and Comroe, J. H.: Use of di-isopropyl fluorophosphate (DFP) in treatment of glaucoma. Arch. Ophth., **36**:1-16, 1946.
17. Leopold, I. H., Gold, P., and Gold, D.: Use of thiophosphinyl quaternary compound (217-MI) in treatment of glaucoma. Arch. Ophth., **56**:363-366, 1957.
18. Grob, D., and Johns, R. J.: Use of oximes in the treatment of intoxication by anticholinesterase compound in normal subjects. Am. J. Med., **24**:497, 1958.
19. ———: Use of oximes in the treatment of intoxication by anticholinesterase compound in patients with myasthenia gravis. Am. J. Med., **24**:512, 1958.

THE DECLINE IN AQUEOUS SECRETION AND OUTFLOW FACILITY WITH AGE*

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A decrease in outflow facility with age has been reported by several observers using different methods of measurement.[1-3] Goldmann's data for human eyes were based upon measurements of rate of aqueous flow as determined by fluorescein turnover.[1] Weekers' conclusions stemmed from tonographic data on 90 normal subjects.[2] Huggert found a similar increase in outflow resistance with age in rabbits by perfusing the enucleated eyes.[3] However, other observers failed to detect tonographic varia-

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TABLE 1

THE VARIATION IN TONOGRAPHY WITH AGE IN NORMAL EYES

Age (yr)	No. Eyes	Intraocular Pressure (P_o)	Outflow Facility (C)	Rate of Secretion (F)
(1) 40 or less	244	16.1±2.7	0.331±0.067	2.02±0.82
(2) 41–60	347	16.9±2.6	0.276±0.047	1.91±0.73
(3) over 60	318	15.2±3.0	0.233±0.046	1.21±0.60
TOTAL	909	16.1±2.8	0.276	1.68

Data expressed as mean values ± standard deviation.

tions in outflow facility in different age groups of human eyes.[4-7] It is the purpose of this study to review a large number of tonograms and a series of perfused enucleated eyes in order to evaluate the variations of facility of outflow and rate of aqueous secretion with age.

METHOD

Tonography was carried out with an electronic tonometer connected to a Leeds and Northrup recorder. The tracings were analyzed using the 1955 Friedenwald tables with the suggested correction for episcleral venous pressure.[8,9] Rate of flow was calculated assuming an episcleral venous pressure of 10 mm. Hg.

Perfusion with buffered saline was carried out on enucleated eyes obtained at autopsy, and the facility of outflow was calculated as described previously.[10]

RESULTS

Tonograms on a total of 909 normal eyes were analyzed (table 1). These were divided into three age groups: (1) those 40 years of age or less, (2) those between 41 and 60, and (3) those patients over 60 years of age. There was little variation in intraocular pressure with age, averaging 16.1 ± 2.8 (S.D.) for the entire series. However, outflow facility declined steadily with age and differences among the three age groups were statistically highly significant.* The rate of aqueous secretion remained essentially constant at 2.0 µl/min to the age of 60 years, and then declined significantly ($t = 13$) thereafter to an average of 1.2 µl/min. The average data further subdivided by decade for pressure, outflow facility, and rate of secretion are presented in Figure 1. In this plot, it is even more evident that, although pressure remains reasonably constant, outflow facility declines steadily with age, and rate of secretion presents a rapid fall off after the age of 60 years.

*t-values for outflow facilities: age group (1) vs. age group (2) = 11; age group (2) vs. age group (3) = 12; age group (1) vs. age group (3) = 20.

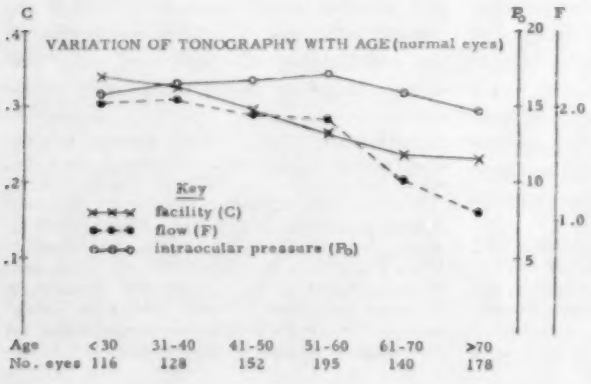

Fig. 1 (Becker). The variation by decade of average values for the outflow facility (C), the rate of aqueous secretion (F), and the intraocular pressure (Po) in normal eyes.

TABLE 2

THE VARIATION IN TONOGRAPHY WITH AGE IN EYES WITH CHRONIC SIMPLE GLAUCOMA

Age (yr)	No. Eyes	Intraocular Pressure (P_o)	Outflow Facility (C)	Rate of Secretion (F)
		(mm.Hg)		(μl/min.)
41–60	420	21.8±3.1	0.149±0.051	1.76±0.84
over 60	490	19.6±2.9	0.112±0.056	1.08±0.59

Data expressed as mean values ± standard deviation.

A similar series of 910 eyes with proved chronic simple glaucoma is summarized in Table 2. At the time of tonography these eyes were all unoperated and were not receiving secretory suppressants. Most of them were on miotic therapy, however. In this group the decline in aqueous secretion after the age of 60 is also highly significant ($t = 14$).

A series of 54 enucleated normal eyes were perfused. The outflow facilities for the three age groups are presented in Table 3. Again, there is a similar decrease in average facility with age, much as in the tonographic data. In spite of the limited number of eyes in the series age 40 years or under, the difference of mean facility values between this group and the 40- to 60-year group is significant statistically ($t = 3$). The differences in outflow facility below and above age 60 are highly significant ($t = 7$).

Discussion

The most consistent tonographic finding in these series of eyes, both glaucomatous and normal, is a marked decline in the rate of secretion of aqueous humor after the age of 60 years. This correlates well with the histologic picture in the ciliary body. An experienced eye pathologist can estimate the age of the patient from the degree of atrophy of the ciliary processes. A greater atrophy and hyalinization of ciliary processes occurs in glaucomatous eyes, corresponding to the lower average secretory rate found.

TABLE 3

THE VARIATION IN PERFUSION OUTFLOW FACILITY WITH AGE IN NORMAL ENUCLEATED EYES

Age (yr)	No. Eyes	Outflow Facility
(1) 40 or less	10	0.390±0.037
(2) 41–60	20	0.334±0.062
(3) over 60	24	0.271±0.054
TOTAL	54	0.318

Data expressed as mean values ± standard deviation.

On the other hand it has been demonstrated that a decrease in outflow facility may fail to produce a rise in pressure because of a reflex compensatory decrease in secretory rate.[11] Such normalization of intraocular pressure in spite of impaired outflow facility is a common finding in glaucomatous eyes. Whatever its mechanism, it is important to emphasize that the decrease in rate of secretion of aqueous humor with age tends to prevent glaucomatous pressure rises and glaucomatous damage to the optic nerve. Physiologic hyposecretion may account for the relatively infrequent occurrence of pressure elevations in spite of the comparatively high incidence of outflow deficiencies found in the eyes of the aged. As indicated above such outflow changes are seen by both tonography and perfusion, and are consistent with the structural changes in drainage channels demonstrated histologically. Fortunately, the appearance of glaucoma with damage to the optic nerve is seen even less commonly than borderline pressure elevations because of such safety factors. Furthermore, hyposecretion as a method of avoiding glaucoma damage provides a more physiologic basis for the use of carbonic anhydrase inhibitors and other secretory suppressants as a similar means of avoiding progression of glaucomatous field loss in eyes with obstructed outflow channels.

The average normal intraocular pressure in the present series (16.1 ± 2.8) agrees well with the findings of Goldmann using the applanation tonometer (15.44 ± 2.75).[12] The differences between the series are probably accounted for by postural differences in applanation and Schiøtz readings. It is important to emphasize that a pressure greater than 20 mm. Hg is very unlikely to occur in the normal population (seven percent of normal eyes in this series). On the other hand, 64 percent of a series of 188 eyes with glaucoma and field loss demonstrated a pressure over 20 mm. Hg when all therapy was stopped.[13] Furthermore, in a study of the three-year prognosis of chronic simple glaucoma treated with miotics, it was found that an initial intraocular pressure less than 20 mm. Hg assured continued control in 74 percent of eyes; whereas a pressure level of 24 mm. Hg or less resulted in only 54 percent successful therapy for this period of time.[14] The findings suggest that glaucoma surveys should use a scale reading of 4.0 with a 5.5 gm. weight as the borderline value requiring further evaluation.

The decline in tonographic outflow facility with age correlates well with the perfusion values and with the increasing pathology in the trabecula.[15, 16] It is also in excellent agreement with the variations in average values derived from fluorescein turnover data[1] (table 4). Of course, it is possible that all such studies include some instances of unrecognized early glaucoma in the older age groups. However, the incidence of such glaucoma would have to be enormously high in order to alter the mean values so significantly. Furthermore, similar tonographic[17] and perfusion[3] changes with increasing age are noted in rabbit and other animal eyes. Interestingly enough the decrease in mean outflow facility with age in the rabbit also amounts to some 30 percent. In beef eyes Huggert has also demonstrated a difference in the pore size distribution curve with more of the smaller pores in eyes from older animals.[18]

It is conceivable that a part of the decrease in facility with aging may result from a decreasing volume of the anterior chamber. The decrease in size of the anterior chamber with age has been reported in several large series and is related in part to the increasing lens volume.[19] It has been demonstrated that outflow facility is proportional to the volume of the anterior chamber in the enucleated eye as well as in the markedly different sized eyes of various species.[20] This interesting relationship of anterior chamber volume and outflow facility may provide a mechanism for constancy of composition of the aqueous humor in various species and in various sized anterior chambers. Thus for a given intraocular pressure, rate of flow varies with outflow facility, and thus secretion expressed as a percent of the anterior chamber remains more constant. However, although the average depth and mean volume of the anterior chamber decrease progressively with age, they do not change enough to account for all of the de-

TABLE 4

COMPARISON OF AGE CHANGES IN MEAN VALUES FOR OUTFLOW FACILITY AND SIZE OF ANTERIOR CHAMBER IN NORMAL HUMAN EYES

Age (yr)	Outflow Facility			Anterior Chamber	
	Tonography	Perfusion	Fluorescein*	Volume (μl)*	Depth (mm.)†
(1) 40 or less	0.33	0.39	0.39	187	3.0
(2) 41–60	0.28	0.33	0.36	172	2.7
(3) over 60	0.23	0.27	0.27	145	2.4

* Data of Goldmann.[1]
† Data of Tornquist.[21]

cline in outflow facility[1,21] (table 4). In fact, the reported decreases in anterior chamber volume with age might be expected to account for only about 50 percent of the observed fall in outflow facility.

It is also possible that the decrease in facility of aqueous outflow may be a reflex or compensatory change to the declining secretory rate. This has been demonstrated as a mechanism for maintaining intraocular pressure in spite of secretory inhibition by carbonic anhydrase inhibitors.[22] However, this latter explanation seems unlikely because the in vivo outflow facility persists in the enucleated eye. Furthermore, the facility correlates with histologic changes seen in the trabecula of presumably normal eyes of older individuals.

Although cause and effect cannot be established, it is apparent that the simultaneous decline in outflow facility and secretory rate with age provides an excellent mechanism for maintaining intraocular pressure at a reasonably constant level throughout life. In these terms glaucoma may be defined as a failure to decrease secretion in proportion to the decline in ouflow facility, or as an excessive decrease in outflow facility at a given secretory rate. Even in eyes with established glaucoma, the decline in secretion with age permits a decrease in pressure in spite of the outflow disorder, tends to avoid progression of the field defects, and explains many instances of so-called "low-tension glaucoma." On the other hand it is this same decline in secretion with age that makes detection of glaucoma so difficult when single pressure measurements alone are used. The eye with a disordered outflow mechanism has less capacity than the normal for compensating for changes in secretion of aqueous. Small increases in secretory activity result in larger pressure elevations. Therefore it is important to recognize impaired outflow facility and to follow such eyes as potentially glaucomatous.

Summary

1. In normal eyes tonography reveals a significant progressive decrease in average outflow facility with age from an average of 0.33 for eyes 40 years of age or under to 0.23 for those over 60 years. This is associated with a significant sharp decline in average rate of aqueous secretion after the age of 60 years. Intraocular pressure is therefore maintained reasonably constant at all ages.

2. Perfusion measurements as well as fluorescein turnover studies confirm the increasing resistance to outflow with age in normal eyes.

3. Eyes with chronic simple glaucoma also demonstrate a significant decrease in secretory rate with advancing age. This hyposecretion may prevent pressure damage in spite of the outflow disorder.

4. Intraocular pressures over 20 mm. Hg occur in only seven percent of normal eyes, and therefore a scale reading of 4.0 with the 5.5-gm. weight suggests careful evaluation for glaucoma.

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References

1. Goldmann, H.: Abflussdruck, Minutenvolumen und Widerstand der Kammerwasserstromung des Menschen. Documenta Ophth., **5-6**:320, 1951.

2. Weekers, R., Watillon, M., and de Rudder, M.: Experimental and clinical investigations into the resistance to outflow of aqueous humor in normal subjects. Brit. J. Ophth., **40**:225, 1956.

3. Huggert, A.: An experiment in determining the pore-size distribution curve to the filtration angle of the eye: I. Acta ophth., **35**:12, 1957.

4. Grant, W. M.: Tonographic method for measuring the facility and rate of aqueous flow in human eyes. Arch. Ophth., **44**:204, 1950.

5. deRoetth, A., and Knighton, W. S.: Clinical evaluation of the aqueous-flow test: A preliminary report. Arch. Ophth., **48**:148, 1952.

6. Spencer, R. W., Helmick, E. D., and Scheie, H. G.: Tonography: Technical Difficulties and Control studies. Arch. Ophth., **54**:515, 1955.

7. Boles-Carenini, B., and Cambiaggi, A.: Are aqueous humor dynamics influenced by aging? Am. J. Ophth., **44**:395, 1957.
8. Friedenwald, J. S.: Tonometer calibration: An attempt to remove discrepancies found in the 1954 calibration scale for Schiøtz tonometers. Tr. Am. Acad. Ophth., **61**:108, 1957.
9. Moses, R. A., and Becker, B.: Clinical tonography: The scleral rigidity correction. Am. J. Ophth., **45**:196, 1958.
10. Becker, B., and Constant, M. A.: The facility of aqueous outflow: A comparison of tonography and perfusion measurements in vivo and in vitro. Arch. Ophth., **55**:305, 1956.
11. Becker, B., and Friedenwald, J. S.: Clinical aqueous outflow. Arch. Ophth., **50**:557, 1953.
12. Goldmann, H.: In Glaucoma: Tr. Second Conference (Edited by F. W. Newell). New York, Josiah Macy, Jr. Foundation Publications, 1957.
13. Becker, B., and Christensen, R. E.: Water-drinking and tonography in the diagnosis of glaucoma. Arch. Ophth., **56**:321, 1956.
14. Becker, B.: The prognostic value of tonography in the miotic therapy of chronic simple glaucoma. Am. J. Ophth., **46**:11 (July, Pt. I), 1958.
15. Rohen, V. J., and Unger, H. H.: Feinbau und Reaktionsmoglichkeiten des Trabekelwerkes im menschlichen Auge. Anatomischer Anzeiger Bd., **104**:11, 1957.
16. Teng, C., Paton, R. T., and Katzin, H. M.: Primary degeneration in the vicinity of the chamber angle: As an etiologic factor in wide-angle glaucoma. Am. J. Ophth., **40**:619, 1955.
17. Constant, M. A., and Becker, B.: Unpublished observations, 1957.
18. Huggert, A.: An experiment in determining the pore-size distribution curve to the filtration angle of the eye: II. Perfusion experiments with isobutyl alcohol on the eyes of Cattle. Acta ophth., **35**:104, 1957.
19. Snydacker, D.: The relation of the volume of the crystalline lens to the depth of the anterior chamber. Tr. Am. Ophth. Soc., **54**:675, 1956.
20. Becker, B., and Constant, M. A.: Species variation in facility of aqueous outflow. Am. J. Ophth., **42**:189 (Oct., Pt. II), 1956.
21. Tornquist, R.: Shallow anterior chamber in acute glaucoma: A clinical and genetic study. Acta ophth., Supp. 39, 1955, p. 1.
22. Becker, B., and Constant, M. A.: Experimental tonography: The effect of the carbonic anhydrase inhibitor acetazolamide on aqueous flow. Arch. Ophth., **54**:321, 1955.

PREDNISOLONE-21 PHOSPHATE-NEOMYCIN SULFATE SOLUTION IN OPHTHALMOLOGY*

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The search for new topical and systemic adrenal cortical steroids continues. This paper reports the results of over one year's experience in a large variety of ophthalmic conditions with a solution of prednisolone 21-phosphate-neomycin sulfate as an eye-drop.

BLEPHARITIS

Thirteen cases of marginal blepharitis were treated with this solution approximately four times daily. All patients had an almost immediate beneficial response to the solution, with paling, lessening of lid edema, and marked decrease in lash margin inflammation and scaling. Ten of the patients were practically recovered within two weeks but were continued an additional two weeks on the medication. In three other patients the response within the initial week was not sufficiently impressive to warrant continuance of therapy with the solution alone. With them an ointment of prednisolone with neomycin was employed additionally night and morning. These three patients also required lid massage with a glass rod to express some meibomian secretion.

All patients with scales on the lash margin are routinely taught to cleanse the lash margins with a moist toothpick cotton applicator, or simply with some surgical cotton. They are taught to scrub all scales from the lash margins. It is well known that medica-

* From the New York Hospital-Cornell Medical Center and the L. Margolyes League. The solution of prednisolone-21 phosphate-neomycin sulfate was supplied as Neo-Hydelfrasol through the courtesy of Merck-Sharp & Dohme Company.

tion will be absorbed poorly, if at all, through scales or crusts.

Five of these patients had rather marked associated seborrhea of the scalp, and all of them were given instructions in scalp care.

Acute and subacute catarrhal conjunctivitis

Seventy-six patients with acute and subacute catarrhal conjunctivitis were treated with the solution of prednisolone 21-phosphate with neomycin. None of these patients were found to have palpable preauricular nodes. Forty-seven of the patients improved markedly within 24 to 36 hours. The others required from four to seven days before marked improvement was noted. All of these patients were instructed to employ the medication for an additional seven to 10 days after all signs and symptoms of the conjunctivitis had disappeared. Two of the group required additional antibiotic ointment at night for one week before they improved.

Chronic conjunctivitis

Eighteen cases of chronic catarrhal conjunctivitis, all of which had existed for at least one or two months prior to the first visit, were treated with the prednisolone 21-phosphate-neomycin. Eleven of these made an excellent response to the medication within one week of initiation of treatment. They were then carried for an additional two to three weeks beyond the point when all signs and symptoms had disappeared. Two other cases were severe and required one application of silver nitrate to the lids before a response significant enough to warrant continuation on the eye drops alone was noted. Five others had sufficient evidence of chronic meibomianitis to necessitate lid massage plus several injections of staphylococcus toxoid. On this latter regimen excellent results were secured. In all cases the topical medication was continued for an additional two weeks beyond the point of recovery.

Acute hordeolum and meibomianitis

Thirty-four cases in this category were treated with the solution. Seven went on to chalazion formation which required surgical drainage. Twenty-seven exhibited marked clearing within three to seven days. Those of short duration did best on medical therapy. Of the 27, two cases were so badly inflamed that I prescribed the medication almost against my better judgment. In all cases where there is no obvious chalazion or stye, I routinely employ lid massage at the first visit. While this procedure alone is often beneficial, it has not been my experience that it is adequate to abort the condition in most cases. However, it is a very helpful adjunct. Massage was not done in the case which is pictured here (figs. 11 and 12), since it would have been too painful. This patient had 250 mg. of sodium novobiocin four times daily during the first day of his treatment. When topical steroid-antibiotic combinations are employed routinely early in the course of an acute meibomianitis or an acute hordeolum, the results are often dramatic.

Keratitis

These cases were all either superficial punctate keratitis or limbal ulcers (catarrhal ulcers). There were six cases of superficial punctate keratitis with palpable preauricular nodes. In none of these six patients did scrapings of the cornea reveal evidence of virus. All responded rapidly to the solution within 48 hours of initiation of therapy. Two of these cases were atypical and quite severe, exhibiting retinal folds and edema. On slit-lamp examination, all were free of keratitis within two to three weeks.

There were nine patients with marginal or limbal ulcers. All of these responded more rapidly than those with the superficial punctate keratitis, exhibiting marked clearing within 24 to 48 hours, and being free of symptoms and signs within 10 days of the beginning of therapy.

Chronic dacryocystitis

Five cases of chronic dacryocystitis were treated with topical instillations of the prednisolone 21-phosphate with neomycin, used

approximately four times daily. All of these were also irrigated every week or two with a two-percent solution of clorpactin WCS90. While all of these patients exhibited marked clinical improvement, varying degrees of discharge still continued. In all cases, the improvement, noticed both by the patient and by the examiner, was marked, but a cure did not result. This coincides with the author's experiences with other forms of medication. He knows of no medicinal cures for chronic dacryocystitis.

Acute and chronic lid allergies

Eight cases of unilateral or bilateral lid edema of the type commonly thought to be due to allergy were treated. Two of these were associated with the use of atropine sulfate solutions. All exhibited marked improvement within one to three days and were relieved within seven to 14 days. Two, however, required additional 10 mg. daily doses of prednisolone before a satisfactory result was observed. In all of these cases an additional one to two weeks of topical therapy was employed following clearing. Three other chronic cases of what were thought to be lid allergies did well while on the topical solutions, but relapsed when medication was discontinued. Relapses would occur within several days to a week or two of discontinuance of therapy. Two of these patients had had studies by allergists which gave no helpful information. Two other chronic patients required additional occasional systemic prednisolone or a combination of prednisolone and an antihistaminic drug to secure a satisfactory improvement.

Central corneal ulcers

Three cases of ulcers following incomplete removal of metallic corneal foreign bodies did well with the topical solution employed from four to eight times daily. All of these showed immediate beneficial response. Of the three, two were cured within one month, and one required two months of therapy for satisfactory results. In all of these cases the marked areas of infiltration and edema surrounding the incompletely removed rust ring disappeared, leaving only a tiny nebula.

Episcleritis

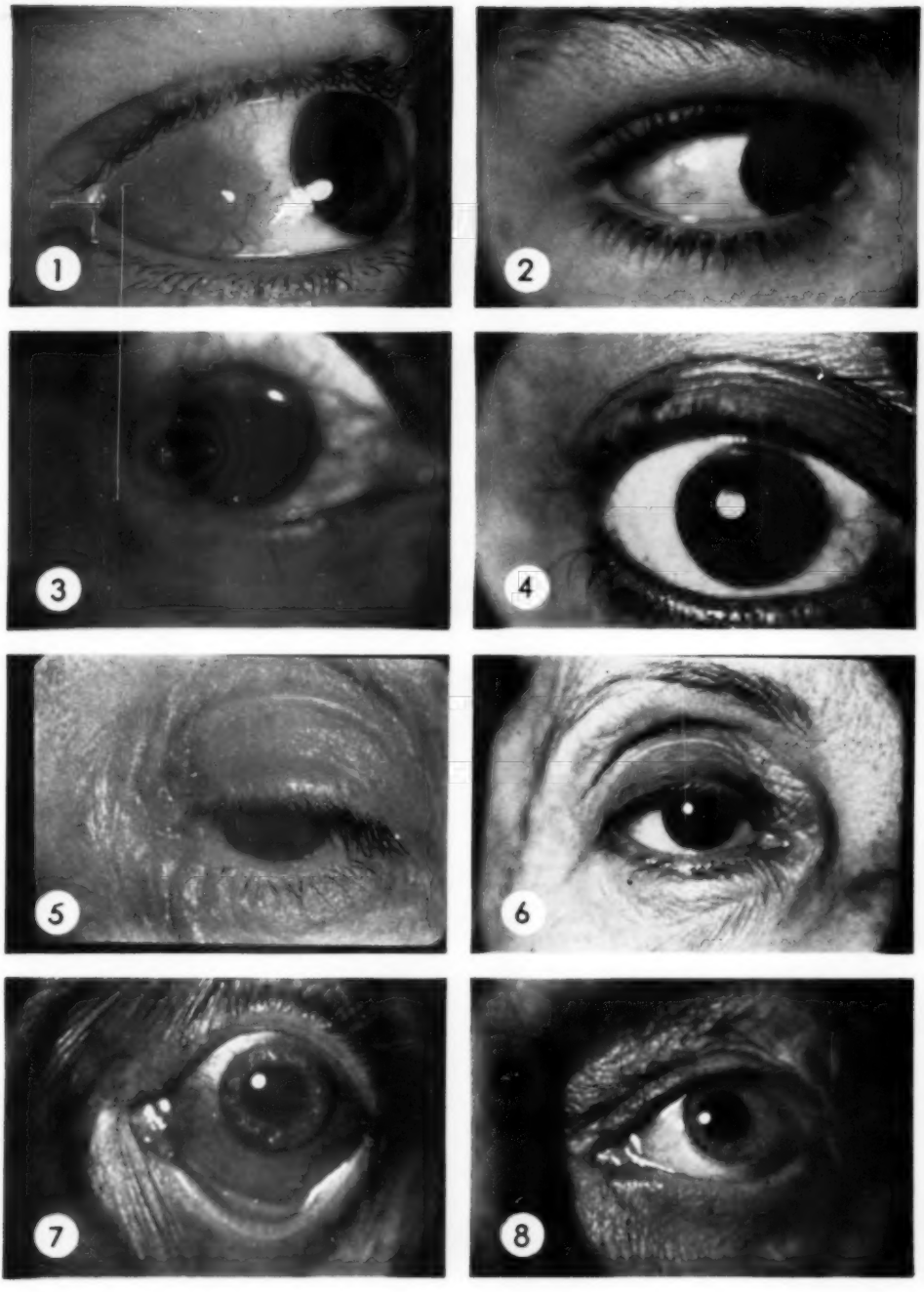
Four cases of episcleritis were treated with the solution of prednisolone 21-phosphate with neomycin. All of these did well with the medication, exhibiting prompt relief and clearing of the injected areas. Three cleared entirely within three to four weeks. One patient was resistant, although he did improve on the topical solution. However, 20 mg. of prednisolone was given systemically daily for 10 days, following which the cure was complete. In all of these patients the topical medication was continued for an additional two weeks beyond the point where all of the signs and symptoms had disappeared.

Scleritis

One severe case of bilateral deep scleritis was treated. This patient has an associated rheumatoid arthritis, for which she is re-

Key to figures 1 through 8

Figure No.	Patient	Diagnosis	Treatment	Before Treatment	After Treatment
1 and 2	P	Retention granuloma after strabismus surgery	Prednisolone-21-phosphate with neomycin	Fig. 1	Fig. 2 2 months
3 and 4	E	Limbal vernal	Prednisolone-21-phosphate	Fig. 3	Fig. 4 11 days
5 and 6	F	Lid allergy	Prednisolone-21-phosphate	Fig. 6	Fig. 6 4 days
7 and 8	C	Episcleritis	Prednisolone-21-phosphate	Fig. 7	Fig. 8 4 days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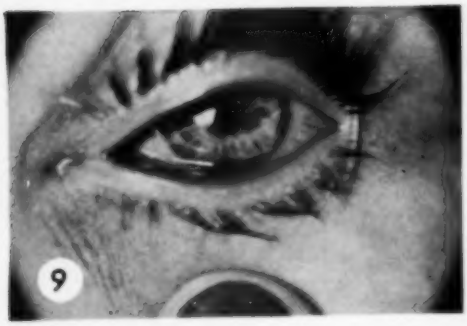
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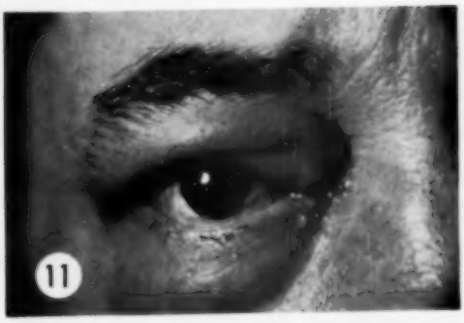
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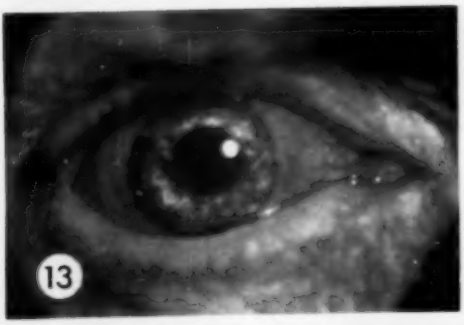
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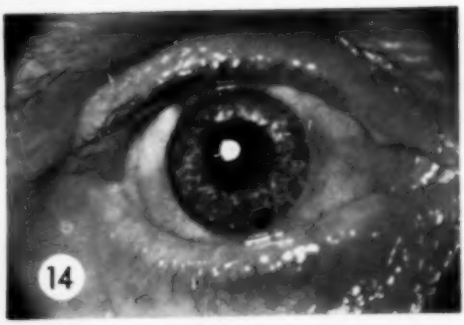
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ceiving systemic corticosteroid therapy from her internist. Her scleras were deep purple in color, exhibiting marked thinning over the ciliary regions, with no areas of scleral ulceration or impending perforation. She was placed on topical medication, six to eight times daily, and, over a period of three months, exhibited a very marked improvement. At this writing the purple color has almost entirely disappeared, and the patient and the observer are quite satisfied with the results.

Iridocyclitis

Eleven cases of acute iridocyclitis were treated with the topical solution of prednisolone 21-phosphate with neomycin. Eight responded almost immediately to the topical medication, exhibiting a marked improvement within one to three days. Six of these eight patients were completely free of signs and symptoms within two weeks. Two required additional treatment for a period of approximately one month. The other three patients required the additional use of systemic adrenocortical steroids before a satisfactory result was secured. Cycloplegics were employed in only two of these patients following the first examination. All of the patients were continued on topical therapy for an additional two weeks following the disappearance of all signs and symptoms of the iridocylitis. Two cases of glaucomatocyclitic crisis were treated, responding rapidly to the topical medication, with cessation of anterior segment inflammation and normalization of intraocular pressure.

Granulation tissue

The topical preparation was used routinely in 14 postoperative cases of strabismus. Two of these patients had severe, and three mild, retention granulomas. These masses literally melted away within two to eight weeks. An additional case was seen in an adult woman in which a red mass, approximately five-eighths by one-half inch, was seen on the bulbar conjunctiva. The history gave no clue to the etiology of this lesion. The patient used the eye drops four to six times a day. Within a month, the lesion had almost entirely disappeared. A biopsy, which was done before the patient was completely cured of her mass, revealed chronic granulation tissue. The melting away of this lesion was truly remarkable. The same statement can be made about the two severe retention granulomas referred to above. In presteroid days, these would have necessitated excision.

Postoperative intraocular surgery

Forty-three patients who had had previous intraocular surgery were treated with the topical solution two to four times daily, starting eight to 12 days after their operations. In all of these there was marked paling of the eyes, and alleviation of the itching and burning, without any deleterious effect upon

Key to figures 9 through 16

Figure No.	Patient	Diagnosis	Treatment	Before Treatment	After Treatment
9 and 10	D	Superficial punctate keratitis associated with German measles	Prednisolone-21-phosphate with neomycin	Fig. 9	Fig. 10 9 days
11 and 12	P	Acute meibomitis	Prednisolone-21-phosphate with neomycin. Cathomycin (1.0 gm. first day)	Fig. 11	Fig. 12 4 days
13 and 14	I	Iridocyclitis	Prednisolone-21-phosphate with neomycin	Fig. 13	Fig. 14 4 days
15 and 16	W	Acute catarrhal conjunctivitis	Prednisolone-21-phosphate with neomycin	Fig. 15	Fig. 16 4 days

the wound healing. These patients all employed the medication for from one to two months.

Discussion

Woods and others have constantly emphasized the fact that it is important to employ adrenal corticosteroid eye drops frequently in order to obtain an excellent result. Most ophthalmologists are accustomed to employing topical medication three to four times daily. When one is dealing with a severe ocular inflammation, especially an episcleritis, scleritis, or iridocyclitis, it is advisable to employ the medication as often as possible. Frequently this means one drop every half hour and certainly the one-hour interval should be commonly used. In acute ocular inflammations, the more frequently the drops are employed, the more rapidly the patient will recover.

No patients developed herpes-simplex while on this medication. However, it was not employed in any case of keratitis in which the diagnosis was ambiguous. It is my custom to avoid topical steroid therapy in any corneal situation in which the diagnosis is unclear, and when there is a possibility that herpes simplex is present but that the full picture has not yet developed.

The solution of prednisolone has the advantage over the suspension in that no crystalline residue is left in the patient's cul-de-sac or in his lashes. Many patients complain about the white residue which follows the use of suspensions. The other advantage is that the patient does not have to shake the drops and is therefore sure of receiving a consistent dosage in each drop. Many patients forget to shake the suspension and thus treat themselves with diluents at one time and with a higher concentration of the suspension at another. These disadvantages are obviated by the use of the solution.

Some physicians object to the routine employment of a steroid with an antibiotic for several reasons. Many feel that they would like to employ a steroid alone if indicated, and an antibiotic alone when that is indicated, and a combination when they feel that the two are indicated. One cannot quarrel with such objections. On the other hand, the combination has certain advantages.

The solution is more likely to remain uncontaminated because of the presence of an antibiotic. Few patients employ proper precautions once the eyedropper has touched their lashes and then is returned to the bottle. When infection is present, the combination of the steroid and the antibiotic plays a double role, the steroid reducing the inflammation and the antibiotic combating the infection. The literature is full of examples of the value of a combination of a steroid with an antibiotic. I agree with those who dislike shotgun combinations, although the combination of a steroid and an antibiotic is hardly a "shotgun combination."

At times the physician finds it difficult to make a clear-cut diagnosis; he is then perhaps better off employing a combination of a steroid and an antibiotic. There is no evidence of any deleterious results from the use of the combination. While there are some patients who may be sensitive to an antibiotic, it is a fact that sensitivities to neomycin are extremely rare, and are probably well overcome by the concomitant steroid present.

I cannot agree with those who maintain that patients should not be treated when one cannot make a diagnosis. There is no question but that a proper diagnosis tends to delineate the course of treatment. Nevertheless, there are times when one cannot make an absolute diagnosis in the presence of ocular inflammation and yet the inflammation is clearly present. In these situations the combination of cortical steroids and an antibiotic is often very beneficial. I have already stated the fact that a corticosteroid should not be used topically when herpes simplex is suspected or present. This statement also applies to fungal keratitis.

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NOTES, CASES, INSTRUMENTS

HERPES ZOSTER OPHTHALMICUS*

Report of a case in a three and one-half-year-old child

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There is considerable evidence which suggests that herpes zoster and varicella are caused by the same viral agent. The histologic appearance of the cutaneous lesions are similar,[1] neither virus can be transferred to experimental animals or grown in tissue culture.[2] Elementary bodies, thought to represent the virus,[3] collected from vesicles of both diseases, cannot be differentiated by electron microscopy.[4] Serum from patients convalescing from varicella will agglutinate virus obtained from herpes zoster lesions and vice versa.

This common etiology clarifies the epidemiolgic relationship of the two diseases first observed by Bokay in 1888, and explains the not unusual occurrence of varicella epidemics from contact with a case of herpes zoster. Simpson[5] studied such an epidemic under almost ideal epidemiologic conditions. A single case of zoster was responsible for an outbreak of varicella among children on the small island of Yell in the Shetlands. There concurrently occurred a series of cases whose source could easily be traced to contact with varicella on the mainland. Comprehensive studies indicated that the virus of varicella derived from zoster was identical with the virus of ordinary varicella. The clinical illnesses were indistinguishable, incubation periods the same, both viruses were equally infective against those who had never had either disease, and each virus conferred a protection against the other, which appeared complete.

The clinical manifestation of infection with the virus is, however, influenced by the age at which infection occurs. In adults it commonly manifests itself as herpes zoster, very uncommonly as varicella. The opposite is true of children, who rarely develop herpes zoster. Even more rare is the simultaneous occurrence of the two diseases in the same individual, as recorded in the case reported herein.

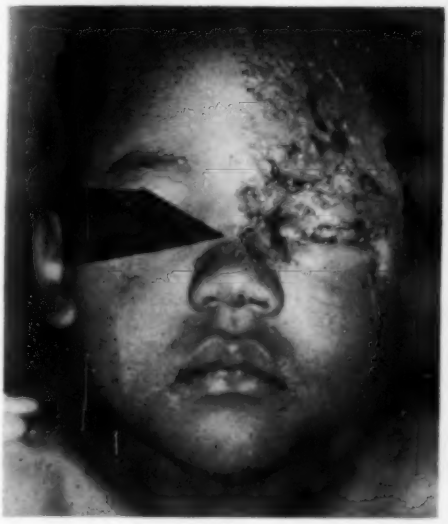

Fig. 1 (Garrett). Appearance of patient.

Case report

A three and one-half-year-old girl was brought into the emergency ward by her parents at night. The left side of her face presented lesions typical of herpes zoster ophthalmicus, apparently involving all divisions of the left ophthalmic nerve (fig. 1). She was quiet, co-operative, seemed to be experiencing very little pain, and otherwise appeared to be in good health. Despite marked edema of both eyelids, a good view of the globe revealed only slight conjunctival and ciliary injection. She had never had varicella or any known recent contact with either varicella or herpes zoster. Her parents stated for approximately 10 days previously, she had complained frequently of severe unilateral headaches and marked photophobia in her left eye.

That night the child was admitted to an open pediatric ward containing 29 children. Six were infants in incubators in an enclosed nursery section of the ward, semi-isolation technique being observed

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in this section. Only six of the 29 children were definitely known to have had varicella.

On admission, the patient's temperature was 38°C. and varied between 37°C. and 38°C. during the first two days. On the third hospital day, her temperature was 40°C. and, when further examined, she was found to have vesicular lesions on her face, chest, palms of hands, and oral mucosa. She now presented classical lesions of both herpes zoster and varicella.

Within three weeks of exposure, four children from this ward developed varicella. One, an infant in the nursery section, had very mild manifestations of the disease, and quickly recovered. Two of the others developed the disease after returning home. The child with herpes zoster and varicella was discharged home and followed in the Eye Out-Patient Department. In spite of the severity of her disease, when last seen, she was making an uneventful recovery.

Summary

1. Despite the differences in clinical manifestations of herpes zoster and varicella, evidence suggests a common viral etiologic agent.

2. The two conditions can occur simultaneously in the same individual.

3. Persons with herpes zoster frequently cause outbreaks of varicella among children.

2065 Adelbert Road (6).

References

1. Thygeson, P.: Ocular bacteriology and virology. Lecture Notes, Lancaster Course, 1956, p. 95.
2. Stokes, J., Jr.: Varicella-herpes zoster group. In Rivers: Viral and Rickettsial Infections of Man. Philadelphia, Lippincott, 1948, p. 395.
3. Duke-Elder, W. S.: Textbook of Ophthalmology, St. Louis, Mosby, 1938, v. 2, p. 1892.
4. Rake, G.: The relationship of varicella and herpes zoster: Electron microscopic studies. J. Bact., **56**:293, 1948.
5. Simpson, R. E.: Studies on shingles: Is the virus ordinary chickenpox virus?, Lancet, **267(2)**:1299, 1954.

CONGENITAL RETINAL DETACHMENT*

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and

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The differential diagnosis of a white mass present in the pupillary space of an infant is often one of the most distressing and difficult problems that an ophthalmologist encounters. Beers,[1] in 1817, first wrote of this entity and described the appearance of the eye as that of an "amaurotic cat's eye" and described it as showing a clear cornea, anterior chamber, and lens, and a white surface in the vitreous capable of reflecting light.

In 1950, Reese[2] suggested the use of the term, leukokoria, or white pupil, to designate those cases in which a white reflex was found in the pupillary space. Pseudoglioma or pseudoretinoblastoma have often been applied to this phenomenon.

Reese listed three congenital manifestations of leukokoria: (1) retrolental fibroplasia—found in premature infants; (2) persistent hyperplastic primary vitreous—found in full-term infants and unilateral in nature; (3) retinal dysplasia—occurring bilaterally in full-term infants with microphthalmic eyes.

Dysplasia of the retina is usually associated with other developmental abnormalities, such as cerebral, cardiac, and bone anomalies. Krause[3] listed a series of 18 cases, 13 of which probably represented retrolental fibroplasia and five of which were in full-term infants who not only had retinal but also cerebral abnormalities.

Laval and Chatzinoff[4] presented a case of a seven-month-old hydrocephalic child with a microphthalmic eye and a normal eye, the microphthalmic eye having a complete retinal detachment. This probably represented an atypical form of a retinal dysplasia.

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* From the Good Samaritan Hospital Eye Pathology Laboratory. This report was aided by the Clinton T. Cooke Memorial Fund. Presented to the Ophthalmic Pathology Club, Western Division, November 14, 1957.

Poulsen[5] reported a case in which an infant had a congenital retinal fold in a normal sized eye combined with a complete retinal detachment in a microphthalmic eye. He felt that the detachment represented an atypical form of the congenital septum. We believe this probably represented different stages of the same process.

The problem of separation of the retina in full-term infants has been reviewed by Heath.[6] In addition to dysplasias, he discussed those due to inflammatory, vascular, and neoplastic conditions. In considering the dysplasias he noted not only the incompleteness of the retinal structure but also the lack of formation of secondary vitreous which is necessary to force the retina against the choroid, leading to folds, stalks, and massive separations.

Congenital detachments have occurred in successive generations as a sex-linked developmental anomaly. One series has been traced by Wilson[7] through six generations, being manifest in males as a recessive sex-linked characteristic.

The embryologic predisposition for the production of retinal septa was first presented by Mann[8] who postulated the theory that there was an adhesion formed between the primary vitreous and the neural ectoderm so that the inner layer of the optic cup was pulled forward and detached in the area of the adhesion. In a later article[9] she grouped the rosettes, folds, congenital detachments, and septa together and stated that they are all anomalies of the inner layer of the optic cup. Secondly, Mann believes, they usually arise after the 13-mm. stage when the cleft is closed and do not fall into the class of colobomas. Thirdly, they are anomalies of proliferation with imperfect differentiation. In addition she pointed out that in the normal development of the eye there is a complete or partial persistence of the cavity of the primary optic vesicle, so that detachment can be due to either excess or insufficient growth of the inner layer of the optic cup.

Fig. 1 (Thornfeldt and Reeh). White stalklike mass attached peripherally to the ciliary body, centrally to the lens, and posteriorly to the optic nerve. The lens is displaced forward to the cornea.

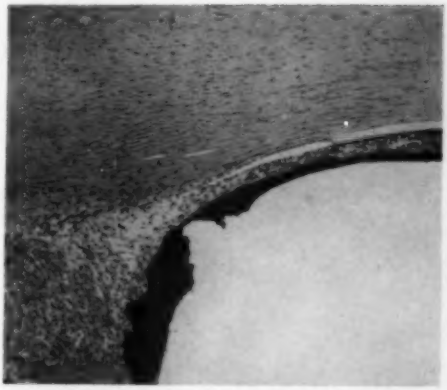

Fig. 2 (Thornfeldt and Reeh). Forward displacement of the iris almost obliterating the angle and anterior chamber.

Case report

An 11-week-old white boy was seen because of a white mass in the pupillary space of the right eye. The mother, father, and four siblings demonstrated no evidence of any eye pathology or other known abnormalities. The mother's prenatal course was uncomplicated, delivery was at term, spontaneous in character, and the child cried immediately. The birth weight was seven pounds and the baby's postnatal course was without incident. Physical examination showed no abnormalities other than the white pupil. Because of extenuating family circumstances, the child had been placed for adoption and the

Fig. 3 (Thornfeldt and Reeh). Fibrovascular membrane behind lens.

future parents were extremely anxious to know the exact status of the mass in the eye before proceeding further.

Examination of the infant under general anesthesia showed the right eye to be definitely smaller than the left. Cornea, O.D., 9:5 mm.; O.S., 10.5 mm. Intraocular pressure: O.D., 30 mm. Hg; O.S., 20 mm. Hg (Schiøtz). The cornea of the right eye was clear, the anterior chamber extremely shallow, the lens was clear and displaced forward so that it almost touched the cornea. There was, immediately behind the lens, a white mass containing vessels. Dentate processes were not visible. The mass which appeared to occupy the vitreous chamber seemed to extend forward more in the central part. X-ray study of the eye showed no calcium granules.

Gross examination. The eye measured in its anteroposterior diameter, 18.5 mm., and horizontal diameter at the equator 16.5 mm. Vertical callotes were made. Behind the lens there was a white stalk-like mass which appeared to be attached to the ciliary body on the periphery and the lens centrally, and extended back to the optic nerve. (fig. 1).

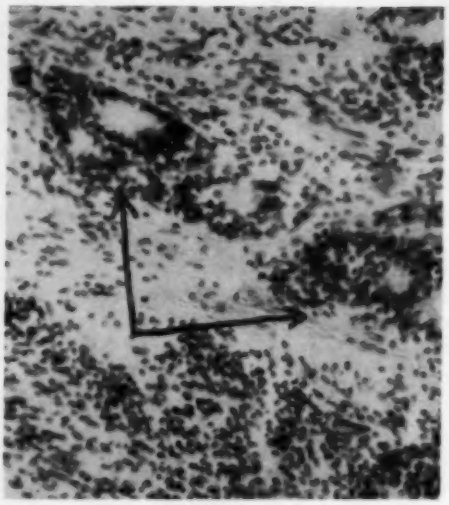

Fig. 4 (Thornfeldt and Reeh). Rosettes found in numerous areas of the retrolental mass.

Microscopic examination. The iris and lens were displaced forward so far that the anterior chamber was almost obliterated (fig. 2). Immediately behind the lens was a layer of fibrovascular tissue which was more dense peripherally. This in part represents persistence of the primary vitreous (fig. 3). The retinal tissue was undifferentiated and there were numerous areas of rosette formation representing imperfect differentiation of the retina (fig.4). There was no evidence of persistence of the hyaloid artery.

Summary

The principal causes of leukokoria have been discussed and the embryology underlying the development of folds, retinal septa, and detachments has been presented.

A case report of a retinal detachment in a full-term male infant has been presented in detail.

919 Taylor Street Building (5).

References

1. Beers: Cited by Wetzel, J. O.: Pseudoglioma of the retina. Am. J. Ophth., **24**:164-173, 1941.
2. Reese, A. B., and Blodi, F. C.: Retinal dysplasia. Am. J. Ophth., **33**:23-32, 1950.
3. Krause, A. D.: Congenital encephalo-ophthalmic dysplasia. Arch. Ophth., **36**:387-444, 1946.
4. Laval, J., and Chatzinoff, A.: Congenital retinal detachment in microphthalmia associated with internal hydrocephalus, J. Mt. Sinai Hosp. N.Y., **22**:54-57, 1955.
5. Poulsen, A. G.: Ablatio falciformis cong. atypica. Acta Ophth., **25**:447-453, 1947.

6. Heath, P.: Massive separation of the retina in full-term infants and juveniles. J.A.M.A., **144**:1148-1154, 1950.
7. Wilson, W. M. G.: Congenital blindness (pseudoglioma) occurring as a sex-linked developmental anomaly. Canadian M.A.J., **60**:580-584, 1949.
8. Mann, I.: Congenital retinal fold. Brit. J. Ophth., **19**:641-658, 1935.
9. ———: Developmental Abnormalities of the Eye. Philadelphia, Lippincott, 1957, ed. 2, p. 188.

MENINGIOMA OF THE OPTIC NERVE

Of one month's clinical duration

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and
John R. Finlay, M.D.
Port Chester, New York

Meningiomas (dural endothelioma) of the optic nerve are relatively rare and are usually of a chronic nature. It is the purpose of this paper to report a primary meningioma of the optic nerve of one month's clinical duration.

Primary tumors of the optic nerve were first classified by Hudson in 1912 and subsequently by Mathewson in 1930. They divided the tumors into gliomas, meningiomas, and fibromas. By 1930, there were 33 meningiomas reported in the literature. Since that time less than a hundred more have been reported. Benedict and Forrest each report 17 cases in two separate series and Reese reports 20 cases. There have been several other reports of individual cases. Meningiomas comprised about eight percent of the total intraorbital tumors for both Reese and Forrest, and about four percent of the total intraorbital tumors in Benedict's series. In all of the cases reported the symptoms were of six months' to 20 or more years' duration with the symptoms usually being proptosis followed by visual loss and lack of movement.

Report of case

The patient, a 39-year-old white woman, was first seen at New York Eye and Ear Infirmary on November 30, 1956, complaining of poor vision of the right eye of two weeks' duration. At that time her vision was 20/100 corrected in the right eye and 20/20 corrected in the left eye. Past history revealed that the patient had a thyroidectomy six years previously and seemed to be well controlled subsequently. She had recently obtained bifocals for occasional blurring of both eyes. Otherwise the history was negative.

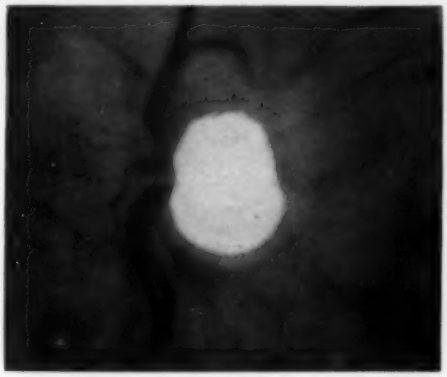

Fig. 1 (Edwards and Finlay). Photograph, showing the disc elevated six diopters.

On examination the ocular movements were of full range and the left eye was completely normal. The anterior segment of the right eye was negative, but funduscopy revealed a two diopter elevation of the disc with distinct disc margins. Complete blood count, urinalysis, serology, and fasting blood sugar were all normal, except for a mild hypochromic anemia.

She was next seen on December 12th when vision in the right eye was found to have fallen to hand motions. The pupil reacted poorly to direct light stimulation but reacted well to consensual light stimulation. Gross field examination showed a general suppression of the whole field. The disc was elevated about six diopters with distinct margins as shown in Figure 1. She was admitted for further study.

Studies while in the hospital. X-ray films of the skull and optic foramen were negative, as were repeated blood counts and urinalyses. Physical examination disclosed a moderate sized uterine polyp which was felt to be coincidental. The vision dropped to light perception in the right eye and the light confrontation field was further diminished. The vision in the left eye remained 20/20 and the perimetry and tangent screen fields of the left eye were normal. There was no ptosis or proptosis of either eye. The exophthalmometer reading was 19 mm. bilaterally and the palpebral fissure was eight mm. bilaterally. It was felt that this was a tumor of the optic nerve and an enucleation was performed on December 19th.

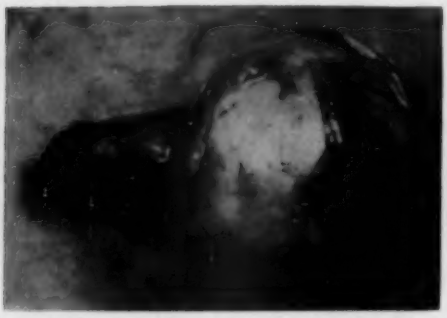

Fig. 2 (Edwards and Finlay). Gross specimen, showing 15 mm. of optic nerve with bullous swelling adjacent to the globe.

At operation a section of the nerve 15 mm. long was obtained. Grossly there was a large bullous swelling eight mm. in diameter for the bulbar eight mm. of the nerve, which can be seen in Figure 2. This tapered sharply so that the cut end of the nerve appeared normal. The nerve was severed postoperatively from the globe with an incision through the bullous swelling. The nerve was seen to be about two-mm. thick with a three-mm. cuff of tumor around the nerve. The two specimens were sent to the laboratory separately so as to secure serial sections on the nerve.

Pathology

Gross examination of the specimen has already been described. Microscopic examination of the nerve segment shows the optic nerve surrounded by broad, elongated cells which arrange themselves in coarse whorls and broad sheets, separated by thick fibrovascular septa into lobules. The individual cells are quite uniform in size, shape, and staining reaction. The chromatin arrangement consists of fine granules rather evenly distributed. There is no suggestion of infiltration and the posterior sections appear to be clear of the tumor.

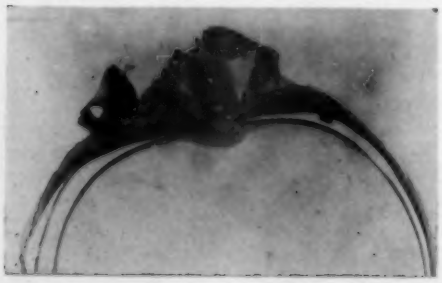

Fig. 3 (Edwards and Finlay). Microscopic section through optic disc, showing lobules of tumor cells surrounding the optic nerve. Also optic papilla is seen prolapsed 1.5 mm. in the vitreous.

Fig. 4 (Edwards and Finlay). Microscopic section under high power, showing the tumor cells in coarse whorls and broad sheets, separated by a thick fibrovascular septum.

The anterior half of the globe appears normal grossly and histologically. At the posterior pole (figs. 3 and 4), a tumor is seen which surrounds the optic nerve and is about seven-mm. across. The papilla is seen to be protruding about 1.5 mm. into the vitreous cavity with edema of the surrounding choroid and sclera. The optice nerve is edematous and the tumor surrounding the nerve is circumscribed by dura and lobulated by thick fibroblastic tissue. It contains numerous laminated basophilic colloid psammoma bodies and hyaline pachionian arachnoidal villi. No areas of infiltration were seen.

Comment

Certain features should be mentioned:

1. Meningiomas are usually felt to be slow-growing tumors; however, this patient gave a history of only four weeks' clinical duration. In a two-week period her vision fell from 20/100 to hand motions.

2. Proptosis and limitation of ocular movements are frequent signs of optic nerve tumors; whereas, this patient showed neither sign as late as the day before enucleation.

3. There has been a great deal of discussion of the size of primary optic nerve meningiomas. Verhoeff has questioned the origin of these tumors in the orbit. It is felt that this is another case that seems to fill the requirements for diagnosis of a primary intraorbital tumor.

Summary

A case of meningioma of the optic nerve with a clinical course of only four weeks is presented. The gross and microscopic pathology are discussed. It is felt that this is an intraorbital tumor arising in the optic nerve.

References

Benedict, W. L.: Surgical treatment of tumors and cysts of the orbit. Am. J. Ophth., **32**:763, 1949.

Forrest, A. W.: Intraorbital tumors. Arch. Ophth., **41**:198, 1949.

Hudson, A. C.: Primary tumors of the optic nerve. Roy. London Ophth. Rep., **18**:317, 1912.

Mathewson, G. A.: Primary tumors of the optic nerve. Am. J. Ophth., **13**:880, 1930.

Reese, A. B.: Tumors of the Eye. New York, Hoeber, 1951.

Verhoeff, F. H.: Tumors of the optic nerve. In Cytology and Cellular Pathology of the Nervous System. New York, Hoeber, 1932, v. 3.

COMBINATION UNIT FOR REFRACTORS

Muscle light, multiple reading, and color cards

Ralph J. Carbo, M.D.

Rockville, Maryland

This device, which may be attached to the reading-card clip on the near-point bar of all standard refractors, facilitates all near-point work. Basically, it consists of a 7.0 by 7.0 inch plastic board. On one side is mounted a muscle light (standard penlight with plastic tip modified to shine light at right angle); the opposite side has a series of six stiff base-hinged cards held in vertical position by a sliding control bar, similar to that found in metal desk phone directories. The six-card mount contains reading and color cards. When not in use, the near-point bar lifts out of the way and is locked by a spring clip

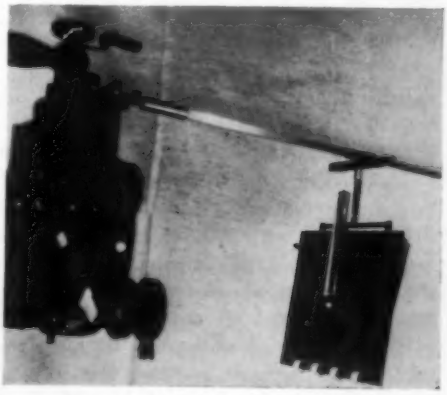

Fig. 2 (Carbo). Use of muscle light, with reading cards on reverse side.

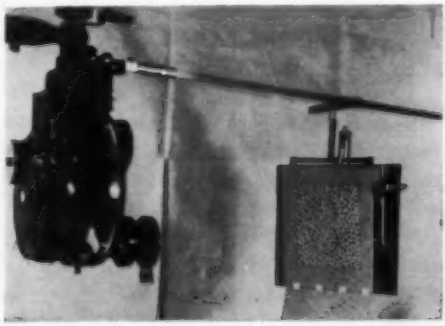

Fig. 1 (Carbo). Use of reading and color cards which fall in sequence by operating control bar at right.

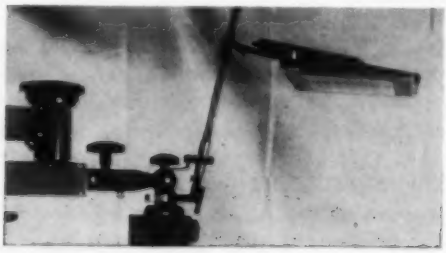

Fig. 3 (Carbo). Combination unit in locked position when not in use, showing spring clip and aluminum sleeve.

attached to the refractor knob. An aluminum sleeve fits over the squared bar.

To operate, swing the unit down, turn on the muscle light for near-point orthoptic measurements, and flip the plastic board to the opposite side. Then, by sliding the control bar down, the reading and color cards will fall in sequence. When through, the cards are replaced; the bar slides up and swings the unit out of position.

809 Viers Mill Road.

POSTERIOR CROCODILE SHAGREEN*

A CORNEAL DYSTROPHY

VICTOR GOODSIDE, M.D.
New York

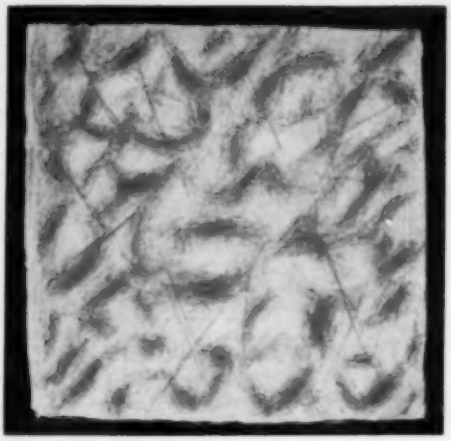

Fig. 1 (Goodside). Posterior corneal shagreen, showing gray patches and two systems of dark intervals.

Justification for making the present report rests first in the fact that no cases of the condition other than those of Weizenblatt in 1928, and Vogt, in 1930, appear in the literature, and second in the possibility of its confusion with a much more common dystrophy —the Fuchs' endothelial-epithelial dystrophy. Two cases of posterior crocodile shagreen came under my observation within a period of several months, one of them the subject of this paper, and the other seen by me through the kindness of Dr. Abraham Reinhorn. Dr. Reinhorn's case was, in most respects, similar to mine, occurring as it did in an elderly woman with senile cataracts. The appearance of the corneas was entirely as indicated in the description of my case.

Vogt[1] used a picturesque term "crocodile shagreen" for two conditions he described, one at Bowman's level and the other at the posterior aspect of the cornea. The clinical appearance of the two was remarkably similar. Weizenblatt,[2] in 1928, had preceded Vogt with a report of six cases of posterior crocodile shagreen. Later authors, Müller,[3] Valerio,[4] Moro Amideo[5] reported cases of the anterior type of crocodile shagreen with several histologic examinations made possible by keratoplasty. The latter showed interruptions of the basophilic Bowman's membrane and separation of the membrane from the corneal epithelium by newly formed connective tissue.

An opportunity to examine histologically posterior crocodile shagreen has not presented itself and, in fact, no case reports of this condition have been found subsequent to Vogt's description in 1930. Berliner[6] alludes to Vogt's work and states that deep crocodile shagreen is even more rare than the superficial variety. Thomas,[7] in his extensive work, *The Cornea,* makes no mention of the condition; nor do Stocker[8] nor Calhoun[9] in their comprehensive studies of dystrophies.

Vogt's case of deep crocodile shagreen was that of a 59-year-old woman who had cataracts and a "senile fundus." It is significant that the cataracts were subsequently removed without deleterious influence on the corneal changes. The corneas showed a lesion of the central one third of roughly cobble-stone appearance in the region of Descemet's membrane. Vogt thought that the lesion might represent a senile change in Descemet's membrane.

* From the Department of Ophthalmology, Montefiore Hospital.

Fig. 2 (Goodside). Slitlamp appearance of posterior corneal shagreen.

Case reports

A 72-year-old man was seen February 27, 1956, with the history of an automobile accident three weeks previously, at which time he suffered a skull injury and was unconscious. On his return to consciousness five hours later he found that he could not see with the left eye. He remained hospitalized for two weeks and during this period X-ray studies of the skull and chest revealed no fracture or other pathologic change. No note was made of the ocular status except for a diagnosis of contusion of the eyelids.

On examination three weeks after the accident, visual acuity in the right eye was 20/70, and in the left eye no light perception. The fundus in the right eye showed nothing abnormal except arteriosclerotic and hypertensive changes in the vessels. The fundus of the left eye showed a pale atrophic disc, probably the result of traumatic interruption of the optic nerve, perhaps in the optic canal. The lenses presented incipient nuclear sclerotic changes. The visual field of the right eye was normal.

The findings responsible for this report were symmetrically present in both corneas and involved the posterior aspect of the middle third. The lesion was a grayish area in the endothelium or Descemet's layer which was broken up into many small, rounded, or polygonal gray patches of varying sizes, separated from one another by dark intervals.

The dark intervals appeared to be of two varieties. One was a system of fine lines crossing obliquely in all directions. The other dark intervals were broader and continuous about the gray patches in such a manner as to produce the appearance of cobblestones or crocodile skin. No evidence of an endothelial mosaic could be made out, since the zone of specular reflection was obscured by the opacities.

The grayish patches were fuzzy in outline and appeared to extend somewhat into the immediately adjacent stroma. The stroma itself was otherwise clear.

A very faint subepithelial opacity was noted occupying the middle third of the cornea, suggesting some involvement of Bowman's membrane. This opacity was faint, had no special character except that it could be visualized most clearly in the cross-section of light. The epithelium showed no involvement.

Over a period of eight months no change could be noted in the corneal condition. The left optic disc became more markedly pale.

Comment

The condition of posterior crocodile shagreen, although obviously rare, is clear cut in its clinical manifestations. Whether the clinical similarity between the anterior and posterior varieties may be considered to reflect histopathologic similarities cannot be stated. Vogt suggested that the crocodile shagreen is a senile change, and this suggestion is strengthened by its occurrence in elderly individuals in the two present cases.

The clinical dissimilarity existing between the crocodile shagreen and Fuchs' endothelial-epithelial dystrophy suggests the following line of thought regarding the pathologic findings to be expected in the former.

At the beginning, Fuchs' dystrophy is marked by excrescenses (cornea guttata) in Descemet's membrane and degeneration of the corneal endothelium. The endothelial degeneration allows the access of fluid to the cornea and epithelial edema and vesiculation occur, finally followed by involvement of the stroma.

In the deep crocodile shagreen there is no involvement of anterior structures beyond the faint opacity of Bowman's membrane which may itself represent an early manifestation of anterior shagreen. In view of the absence of epithelial edema or vesiculation in the present case, which showed extensive involvement of the posterior aspect of the cornea, one may presume that the corneal endothelium is at least functionally in good order. By comparison with the histologic findings in superficial crocodile shagreen one may guess that Descemet's membrane is involved to a considerable extent.

SUMMARY

A case of posterior crocodile shagreen, a rare dystrophy which may be the result of senile degeneration chiefly involving Descemet's zone, was reported.

1777 Grand Concourse (53).

REFERENCES

1. Vogt, A.: Atlas der Spaltlampen mikroskopie des lebender Auges. Berlin, Springer, 1930, v. 1.
2. Weizenblatt: Ztschr f. Augenh. **64**:367, 1927. Quoted by Vogt.
3. Müller, P.: Degenerescence en Mosaique (Chagrin de Crocodile Vogt) de la Membrane de Bowman a la suite d'une keratite traumatique avec Hypopyn. Ann. Ocul., **182**:122, 1949.
4. Valerio, M.: Arch. Ottal. **49**:76, 1942.
5. Moro, F., and Amideo, B.: Relation between corneal degeneration of crocodile skin type (Vogt) and band-shaped keratitis. Clinical and histologic study. Gior. ital. Ophtal., **6**:444-464 (Sept.-Oct.) 1953.
6. Berliner, M. L.: Biomicroscopy of the Eye. New York, Hoeber, 1948, v. 1.
7. Thomas, C.: The Cornea. Springfield, Ill., Charles C Thomas, 1955.
8. Stocker, F. W.: Endothelium of cornea: Clinical implications. Tr. Am. Ophth. Soc., **51**:669-786, 1953.
9. Calhoun, F. P.: Symposium on corneal diseases: Degenerations and dystrophies.

REFINEMENT FOR THE HAND OPHTHALMOSCOPE

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Since the advent of the ophthalmoscope, one of its major handicaps has been the inconvenience caused by annoying corneal reflexes, particularly in study of the macula. This is especially true of the electric hand ophthalmoscope. In the presence of a small pupil this is annoying and frequently necessitates the use of mydriatics for adequate, or even permissible, ophthalmoscopic fundus examinations.

In earlier model ophthalmoscopes, this difficulty was overcome to some extent by the use of an adjustable condensing system so that, among other things, the projected circle of light could be focused and made smaller.[1-3] Later on, the condensing system was made stationary in many models and a small or "pinhole" aperture was inserted which was, in most instances, placed over the condensing lens.

This last innovation is probably the most desirable but it has been my experience that the "pinholes" and other apertures supplied by manufacturers are generally rather large so that the projected circle of light is consequently too large for adequate fundus examination through a small or reactive pupil. By having these apertures made smaller or more nearly a pinhole on the various models of ophthalmoscopes, however, the instruments become much easier to use in routine, white-light ophthalmoscopy. This is because of the smaller circle of light which is projected and this principle is diagrammatically illustrated in Figure 1.

This smaller circle of light causes the corneal reflexes to be much less bothersome and often obviates the necessity for mydriasis even in the pupil constricted with a miotic. This principle is similar to, and in essence is, an application of Gullstrand's "simplified centric reflexless direct ophthalmoscopy" in which he used a very small, intense source of light with a reflecting ophthalmoscope.[4-6]

The Welch Allyn Company has made me,

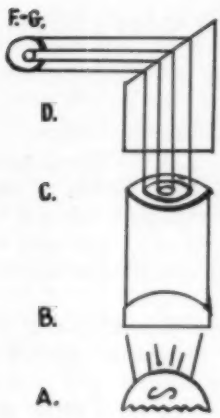

Fig. 1 (Broggi). (A) Light source. (B) Condensing lens. (C) Cap for condensing lens with larger and smaller apertures. (D) Prism. (F) Large circle of light from larger aperture. (G) Smaller circle of light from smaller aperture.

and will supply, a special drum for their no. 110 ophthalmoscope which affords a conveniently smaller circle of projected light; they will also supply a 0.023-inch pinhole cap for their no. 106 ophthalmoscope, which gives the desired result with this model.

For the American Optical Company giantscope, I have made my own modification by substituting a disc with a smaller central aperture which measures between 1.2 and 1.5 mm. As a result, it is possible to use a much brighter light source, which is sometimes desirable, without discomfort to the patient, and the use of the polaroid apparatus is usually unnecessary. Any machine shop can make these discs with the smaller central aperture.

Both the May and Morton ophthalmoscopes can be fitted with pinhole caps which are optimally about one half the size of those that are originally supplied with the instruments. The Bausch and Lomb Optical Company has supplied me with the smaller pinhole caps for these instruments.

The Keeler Company has already incorporated optimally small apertures to supplement the condensing system of most of its models of ophthalmoscopes.

This restriction of the amount of light or total light flux leaving the condensing system may be undesirable for the use of red-free and other filters in some instruments but a rheostatic control may allow the flux density to be brought to the desired level without overloading the bulb. Otherwise, it may be necessary to change to a larger sized aperture and this is, very likely, one reason for the larger apertures which are supplied with many instruments.

My personal experience has been that some instruments which I had been virtually unable to use in routine ophthalmoscopy, became easy to use in the majority of instances after this modification, without using mydriasis. I have never found that the decreased area of fundus illumination is in any way bothersome. Moreover, it is my belief that there are many ophthalmoscopes in virtual disuse in a number of offices and clinics which could become useful instruments if this modification were made. While the use of mydriasis is necessary for a complete and thorough fundus examination, it is certainly not practical nor necessary in all instances and an instrument which facilitates examination through a small pupil is a desirable one. Every funduscopist might properly or advantageously have an instrument with such a modification at his disposal.

36 Pleasant Street (8).

References

1. Bell, W. O.: Recent advances in the construction of the ophthalmoscope. Arch. Ophth., **7**:601 (Apr.) 1932.
2. Langdon, H. M.: The electric ophthalmoscope. Am. J. Ophth., **8**:740 (Sept.) 1925.
3. Graves, B.: Small electric ophthalmoscopes. Brit. J. Ophth., **7**:562, 1923.
4. Friedenwald, J.: A critical study of the modern ophthalmoscope. Contributions to its construction and use. Tr. Am. Ophth. Soc., **26**:381, 1928.
5. Shastid, T. H.: The ophthalmoscope. Am. Encyc. Ophth., **12**:8939, 1918.
6. Examination of the eye. Am. Encyc. Ophth., **6**:4758, 1915.

SOCIETY PROCEEDINGS

Edited by DONALD J. LYLE, M.D.

NEW YORK SOCIETY FOR CLINICAL OPHTHALMOLOGY

December 2, 1957

HARVEY E. THORPE, M.D., *President*

TONOGRAPHY: EXPERIMENTAL AND CLINICAL ASPECTS

The Tenth Annual Mark J. Schoenberg Memorial Lecture (jointly with the National Society for the Prevention of Blindness).

DR. BERNARD BECKER, Saint Louis, said that tonography has proved most useful in diagnosis and evaluation of therapy of the glaucomas. Many of the current uses of this laboratory procedure were anticipated nearly half a century ago by its originator, Dr. Mark Schoenberg.

In regard to the sources of error and correction factors, Dr. Becker said that important correction factors in the clinical and experimental applications of tonography derive from the alterations in episcleral venous pressure during the procedure, and from deviations of the individual eye from the average values for scleral rigidity. Correction for the former source of error is readily accomplished and is included in the current tonography tables. The scleral rigidity coefficient (E) is difficult to estimate but may be approximated most reliably by applanation readings of intraocular pressure preceding the tonogram. If E differs significantly from the average value assumed in the calibration tables, this most important correction can be accomplished by the graphic or algebraic methods described. Unless such correction is made, a high rigidity will simulate glaucoma by tonometry or hypersecretion by tonography; a low rigidity coefficient may lead to failure to recognize glaucoma or to appreciate its inadequate control, and to suggest falsely a state of hyposecretion.

The validity of the tonographic determination of outflow facility is suggested by comparison with data obtained by constant pressure tonography, perfusion in vivo and in vitro, and estimates derived from chemical methods.

As to glaucoma diagnosis, Dr. Becker stated that tonography following a water-drinking provocative test provides unique opportunities for the early detection of chronic simple glaucoma. Similarly, the diagnosis of angle-closure glaucoma can be made more readily by a mydriasis provocative test combined with tonography.

A study of the relatives of glaucoma patients by repeated tonography and provocative tests over a period of years is proving most fruitful. One can demonstrate the early appearance of an outflow disorder and its progression to the point of clinically recognized glaucoma. A study of such selected patients also provides the opportunity for evaluating the efficacy of our detection methods.

Tonographic studies on over 900 normal eyes and almost 1,000 unoperated eyes with chronic simple glaucoma reveal a decline in rate of aqueous secretion with age in both groups. Such hyposecretion may avoid pressure damage in spite of impaired outflow. On the other hand, hyposecretion may be intermittent and lull the ophthalmologist into failing to detect glaucoma or to appreciate its inadequate control.

In the treatment of glaucoma, Dr. Becker said that tonography affords insight into the mode of action of various medical and surgical therapies. It also permits the estimation of the adequacy of such procedures, and the early recognition of their failure even before the occurrence of rises in intraocular pressure and loss of visual field.

In angle-closure glaucoma preoperative

tonography permits an evaluation of the adequacy of the outflow channels and a rational decision as to the type of surgery indicated. A recent study of the results of 209 surgical procedures (100 iridectomies and 109 iridencleises) on 182 eyes with angle-closure glaucoma demonstrates the prognostic importance of evaluating outflow facility before surgery.

The tonographic study of glaucomatous eyes controlled by miotics provides an effective means of predicting pressure rises and loss of visual field. In a series of 200 eyes with chronic simple glaucoma followed for over three years, adequacy of outflow facility induced by the miotic therapy proved to be the best safeguard for continued pressure control and preservation of field.

The use of secretory depressants supplements the lowering of intraocular pressure in those eyes inadequately controlled on miotics alone. Carbonic anhydrase inhibitors, such as Diamox, induce approximately a 50-percent decrease in rate of aqueous production. Topical epinephrine also reduces the rate of aqueous production. Topical epinephrine also reduces the rate of aqueous flow and does so by some 30 to 35 percent. Most exciting is the recent finding that these two agents are essentially additive in their effects on the rate of secretion in human eyes with chronic simple glaucoma, resulting in an average suppression of secretion of 66 percent. The use of maximal miotic therapy and the secretory inhibition afforded by one or both of these agents make possible the successful medical management of a larger number of patients with chronic simple glaucoma.

". . . mere measurement of intraocular pressure . . . is a procedure which may be incomplete and misleading unless the index of ocular drainage is measured at the same time." Mark Schoenberg, 1912.

Jesse Levitt,
Recording Secretary.

ALL-INDIA OPHTHALMOLOGICAL CONGRESS

Indore

February 12 to February 15, 1958

Rodenstock refractometer

The scientific session of the conference opened with the advantages and disadvantages of the assessment of objective refractive error by the Rodenstock refractometer by Dr. Pahwa. The method did not seem to commend itself to the ophthalmic surgeons in India.

Glaucoma symposium

A symposium on glaucoma was held and several interesting papers were read. In the medical treatment of glaucoma, Bhadurie laid stress on avoiding what he calls a provocative habitat such as prolonged cold baths which lead to vascular congestion and attacks of acute glaucoma.

Cooper considered the problem of stress and strain, and deficiency in diet. He suggested that various drugs act in glaucoma according to their action in different places. Tranquilizers like Largactil act on the central nervous system, sympathicolytic drugs act at the spinal level. The miotics act peripherally on the musculature but are unpredictable. Diamox principally acts on the inflow of aqueous but Cooper quoted Hakim and Vazifdar and suggested that it may have an effect on the outflow mechanism.

Firdosi suggested that Diamox should be used in combination with oily drops of pilocarpine.

Agarwal pointed out that there are several stages in the pathology of glaucoma: (1) the stage of vascular instability (prodromal stage), (2) the stage of congestion which may be clinical (congestive) or subclinical (simple), (3) stage of sclerosis, (4) stage of atrophy. It was suggested that the medical treatment should be given for a short time and it should be followed by surgical

treatment. The treatment of all glaucoma is essentially surgical.

Dastoor initiated discussion on surgical treatment for glaucoma and laid down the following indications for surgery: (1) all chronic simple glaucoma, (2) appearance of Rønne's step, (3) persistence of tension in spite of medical treatment and progression of field loss in spite of conservative therapy. He recommended that glaucoma and cataract should be treated in one step without specifying any particular technique.

Dr. Chitnis covered old ground and attempted to classify the glaucoma operations according to the requirements of different types of glaucoma. Agarwal made a plea for adopting his technique of postplaced iridencleisis in acute glaucoma cases and reported a series of 150 original cases in a documented form clearly bringing out its advantages, especially gradual decompression, its adequacy without hazards, and its superiority over other procedures if subsequent cataract extractions had to be done. The technique of the operation was also described in detail.

Madan Gopal (A. V.) suggested an interesting one-stage approach in cases of acute glaucoma precipitated by intumescence of a fully mature cataract, the main step of the operation being (1) small conjunctival flap with three entirely conjunctival sutures, (2) ab externo entry into the anterior chamber with Bard-Parker knife, (3) slow release of aqueous, (4) broad basal iridectomy and lens extractions with minimum pressure.

Other papers read at the conference were either in the nature of case reports or review papers except one on optic neuritis by Gupta, who for the first time presented statistical data on etiologic factors of the disease in this country, and of Putanna, who demonstrated the bacterial flora of the conjunctiva as seen in Indian individuals. He, however, did not record any varying features from those already in the literature.

The WHO team led by Radovanovic gave an account of the work on the Trachoma Pilot Project. It follows the beaten track adding some statistical data of this country without making any outstanding contribution toward the problem facing this country.

Lalit P. Agarwal,
Recorder.

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THE PRESENT STATUS OF ORTHOPTIC PRACTICE*

In order to practice efficiently and to serve best all the people who require his help, an ophthalmologist needs technical assistance. Such technical assistance may take the form of nursing care and help in performing refractions, perimetry, and certain other diagnostic and therapeutic procedures, including those which relate to the neuromuscular anomalies of the eyes. The last is known as "orthoptics" and technicians who assist the physician in orthoptics are known as "orthoptic technicans." Orthoptics, then, deals with defects of ocular motility and of binocular vision. Its scope encompasses both diagnosis and therapy.

Specifically, orthoptic diagnosis includes: 1. Taking visual acuity; that is to say, test-

* The American Orthoptic Council wishes to acknowledge the valuable assistance of Mrs. Lorraine Lorenger in the preparation of this article.

ing vision in each eye separately, and with both eyes together in the presence of binocular vision.

2. Checking ocular motility (ductions, versions, vergences); that is to say, noting any limitations or exaggerations of eye movement as the eyes are turned in the various directions of gaze.

3. Determining the accommodation range and amplitude; that is to say, measuring the ability of the eyes to "focus" or clear images of objects at various distances from the eyes.

4. Measuring any deviations of the visual axis; that is to say, the amount the eyes turn from parallelism. This is uaually done objectively with prisms and/or the major amblyoscope, and subjectively with various tests.

5. Determining the fixing or preferred eyes; that is to say, noting which eye the patient prefers to use.

6. Evaluating the status of binocular vision; that is to say, determining whether, and to what extent, the eyes are capable of working together.

In this phase of her work the orthoptist may be said to perform preliminary or auxiliary duties for the ophthalmologist. From the diagnostic standpoint, the orthoptist's job is to evaluate the binocular status of the patient and to report her findings to the ophthalmologist. It is he who makes the final diagnosis. She should be able, however, to tell the ophthalmologist whether any form of educational training which she may be able to give will, or will not, be likely to benefit the patient. Diagnostically, the orthoptist's most valuable assistance probably consists in the last item for, although the ophthalmologist may check this too in his examination, he often is unable to take the time to do the refined testing possible on the major amblyoscope.

Orthoptic therapy has the following aims:

1. To overcome amblyopia, when present; that is to say, to bring up vision in the usually deviating eye to the level of that in the usually preferred or straight eye, if possible.

2. To break down suppression; that is to say, to stimulate the brain to become aware of the image of the usually deviated eye which has been ignored habitually to avoid the diplopia and/or confusion.

3. To break down anomalous retinal correspondence; that is to say, to stimulate the maculas of both eyes to work together, rather than the macula of one eye and an offmacular area of the other eye.

4. To develop fusional amplitudes (fusional movements); that is to say, to increase the patient's ability to maintain cooperation between the two eyes under stress. This co-operation between the two eyes cannot be taught directly, but can be given maximum opportunity to develop through control of the visual environment.

5. To dissociate accommodation and convergence; that is to say, to teach the patient to exercise clear vision without any accompanying inward deviation of his eyes (when the eyes have a tendency to turn in); or, to teach the patient to exert relatively excessive impulses to turn the eyes inward without blurring the vision (when the eyes have a tendency to turn out).

The nature of orthoptic therapy has been concisely described: "Orthoptic treatment is *not* anatomic, mechanical, or motor. Muscles are *not* being strengthened. Basic binocular alignment is not being changed. Rather, orthoptic treatment is primarily sensory. Two visions are being taught to see as one. Binocular vision is being restored."

From the foregoing it can be seen that orthoptic therapy is primarily an educational or teaching process. Consequently it may be somewhat prolonged since old habits or patterns of seeing must be broken down before new and correct ones can be developed and consolidated. In this respect alone an orthoptist can be of immense value to the busy ophthalmologist who often cannot spend the desired time explaining, demonstrating, and repeating the various details of the steps in a series of treatments. So highly is this phase

of her work regarded that it has been said: "The orthoptic technician is a teacher. Her only complete justification is her ability to train and retrain a pair of dissociated eyes." And again, "Her primary function should be 'treatment.' The orthoptic technician is expendable in all phases of her activity except orthoptic therapy."

After completing her diagnostic evaluation the orthoptist must consult with the ophthalmologist to discuss the form of treatment to be given in each case. Complete treatment may include correction of refractive errors, occlusion, orthoptics, and surgery. In some cases of strabismus the prescription of glasses may be all that is necessary, at least until the child reaches school age; then, depending on the strength of the glasses worn and on the maturity and co-operation of the child, orthoptic exercises may be instituted, directed toward reducing the strength of the glasses and eventually eliminating them while the patient maintains straight eyes with clear vision.

Other types of strabismus may be partially controlled by glasses. These patients are usually given glasses, as well as other forms of treatment aimed at correcting the deviation not affected by the glasses. Still other types of strabismus are not controlled by glasses at all.

Occlusion to bring up the vision in an eye with reduced acuity usually is carried out both in cases proposed for orthoptic treatment and in cases not so destined. Ordinarily, vision in the deviating eye is brought to a point nearly equal to that of the straight eye before active orthoptic exercises are begun.

Surgery is the means of correctly aligning the eyes. It is recommended particularly in cases which are little controlled, or completely uncontrolled, by glasses. The decision as to whether surgery shall be done lies solely within the province of the ophthalmologist, although he may wish the orthoptist's opinion of the patient's readiness to use his eyes together and time his surgery accordingly; for example, when suppression has been eradicated and/or some fusion amplitude has been developed.

Just as spectacles may be ineffective in some cases of strabismus, although 100 percent effective in others, so too orthoptics does not pretend to help all patients with defects of binocular vision. The advisability of orthoptic treatment will depend not only on the diagnostic observations but also on the personality and general health of the child as well as the co-operation likely to be given by patient and parents. Only after all aspects have been weighed can the probability of success be ascertained.

Even after careful screening of patients, the goal of binocular vision may not be attained should unexpected or insuperable obstacles be encountered. However, close cooperation between the orthoptist and the ophthalmologist may resolve many problems, for the ophthalmologist may be able to point out a factor overlooked or unrecognized by his auxiliary.

Since so great a share of her work is with children, the orthoptist must be able to establish a good rapport with them. This necessitates a genuine liking of and interest in them, plus some knowledge of child psychology. Consequently, candidates with teaching backgrounds are looked upon most favorably when applying for training as orthoptic technicians. Other standard prerequisites for training are that the candidate be at least 18 years of age, and that she have a minimum of two years of college or the equivalent. A diploma from a recognized school of nursing or experience in an ophthalmologist's office as secretary and technical assistant for at least two to three years has in the past been acceptable as a substitute for the two-year college requirement.

Ophthalmologists employing orthoptists have obtained their services in one of several ways:

a. Trained an office employee and pre-

pared her for the Council examination.

b. Selected a prospective orthoptist and directed her to the basic course and/or training center.

c. Consulted the Placement Bureau maintained by the American Association of Orthoptic Technicians.

The second method is often the most satisfactory means of obtaining an orthoptist's services, particularly if the ophthalmologist can find a candidate from his own geographic area. Orthoptists working far afield frequently find it necessary to return home for a variety of reasons; then the ophthalmologist must renew his search. As the supply of orthoptists is far short of the current demand, this situation becomes an important consideration to a doctor interested in employing a technician.

As a medical auxiliary, the orthoptist has a fourfold responsibility: (1) to the public; (2) to the ophthalmologist; (3) to the patients and their parents; (4) to the American Orthoptic Council.

1. The orthoptist is a medical auxiliary with complete legal and professional dependence upon the ophthalmologist. She works only with patients referred by him. She is bound by the same ethical principles, and must show the same consideration for her patients and the same respect for their confidences. She must not advertise her services in newspapers, journals, or telephone directories, nor should she have her name lettered on the door of the orthoptic room. The American Orthoptic Council requires that all technicans certified after January 1, 1955, receive remuneration only in the form of a salary. They must not submit bills for services to patients except in the name of the employing ophthalmologist.

2. Because the orthoptist is legally and professionally dependent upon the ophthalmologist, she must accept patients only upon referral from him and must keep in close contact with him regarding the patient's progress. When at all feasible, periodic conferences between ophthalmologist and orthoptist are desirable, to provide an opportunity for mutual exchange of information.

3. If orthoptic treatment is to be given, the orthoptist must not only win the patient's confidence and secure his co-operation; she must also make certain he and/or his parents understand the purposes of the proposed treatment and the procedures which are to be carried out. Exercises given at the office, and particularly those to be done at home, must be carefully explained and demonstrated, and the patient must be stimulated to exert continuing effort to attain the goals set up for him.

4. Should ethical or professional problems arise, the orthoptic technician has a ready source of guidance in the American Orthoptic Council which regulates orthoptic practice as well as setting training requirements and conducting examinations for orthoptic certification. The Council* was organized in 1938 because of the need for properly trained orthoptic technicians and for medical guidance of orthoptic practice. It is composed of three delegates from each of the four leading ophthalmologic organizations: The Section on Ophthalmology of the American Medical Association, The American Ophthalmological Society, The American Academy of Ophthalmology and Otolaryngology, and The American College of Surgeons. Each

* The present members of the American Orthoptic Council are:

J. Mason Baird, M.D., Atlanta, Georgia
Hermann M. Burian, M.D., Iowa City, Iowa
Webb P. Chamberlain, Jr., M.D., Cleveland, Ohio
Edmond L. Cooper, M.D., Detroit, Michigan
Frank D. Costenbader, M.D., Washington, D.C.
John W. Henderson, M.D., Ann Arbor, Michigan
S. Rodman Irvine, M.D., Beverly Hills, California
Philip Knapp, M.D., New York, New York
William E. Krewson, III, M.D., Philadelphia, Pennsylvania
Robert Laughlin, M.D., Seattle, Washington
Angus L. MacLean, M.D., Baltimore, Maryland
John McLeod, M.D., Kansas City, Missouri

In addition, three delegates are appointed from the American Association of Orthoptic Technicians, and the president of the American Association of Orthoptic Technicians sits on the Council as an ex-officio member.

delegate is appointed for a term of three years. The Council works in close co-operation with the parent organizations and submits to each of them a detailed yearly report of its activities.

The major functions of the Council are:

a. To provide basic and practical training for orthoptic students.

b. To provide and encourage continuing postgraduate instruction.

c. To arrange for and conduct examination and certification of orthoptic technician candidates.

d. To regulate professional activities of orthoptic technicans.

Ways in which the first function is fulfilled are outlined in the section on training of orthoptic technicans. Carrying out the second function has been made considerably easier through the kindness of the American Academy of Ophthalmology and Otolaryngology. By making space available at its annual meeting for orthoptic lectures, courses, and exhibits, by lining up special instruction courses through its delegates to the Council and through its courtesy in publishing the American Orthoptic Journal the Academy has demonstrated a genuine interest in helping technicians further their knowledge of orthoptics.

The three-part examinations leading to certification of orthoptic technician candidates are conducted annually by the Council. Performance on the written examination determines whether or not candidates will be permitted to take the oral and practical portions. The written examination, compiled from questions submitted by the Examination Committee of the Council, represents 25 percent of the candidates' examination mark. The oral and practical examinations, administered by Council members and guest technicians, comprise 25 and 50 percent of the final mark respectively.

The fourth Council function is of great importance, to the medical profession, to the technician, and to the public. By stipulating conditions under which orthoptic technicians may practice, the Council assures itself that ethical principles will not be violated; at the same time, the technician is protected against possible legal entanglements. Coincidentally the public is given reasonable assurance that a technician certified by the Council and currently sponsored by an ophthalmologist has an adequate background in orthoptics, has been practicing in accordance with the recommendations of the Council, and is in good standing.

The code of rules governing the deportment of orthoptic technicians (revised 1955) follows:

1. If I receive a Certificate of Approval as a qualified orthoptic technician from the American Orthoptic Council, I promise faithfully to abide by these and all other rules promulgated by the Council.

2. I will act as a technician only to ophthalmologists, and will co-operate with them and carry out their instructions to the best of my ability.

3. In order to protect my legal and ethical position, I agree to receive remuneration only from my employing ophthalmologist, group of ophthalmologists, hopsital, or medical center.

4. I will do no orthoptic work not directly prescribed by an ophthalmologist, nor administer any treatment not approved by him.

5. I will not give, or offer to give, any rebates or commission for referred work.

6. I will not advertise, nor co-operate in publicity regarding orthoptics except as approved by the Council.

7. I will publish no articles on orthoptics in other than recognized medical journals, expect after specific approval by the Council.

8. I will not act as instructor to laymen or to other technicians or students who have not complied with the requirements for training prescribed by the Council.

9. So long as I am engaged in orthoptic work I will fully and faithfully co-operate with the Council and carry out its instructions to the best of my ability.

10. I agree that any Certificate of Approval issued to me is the property of the Council and is subject to revocation by, and return to, the Council and to annual renewal, and that I have no vested right therein or to the approval or certification of the Council.

_____ _____

Date Signature

Prior to the organization of the American Orthoptic Council the training of the American orthoptic technician was far from

standard and often far from satisfactory. Some few orthoptic students met the expense of traveling to England for their training; the majority gathered what knowledge they could from ophthalmologists interested in making the benefits of orthoptics available to themselves and their patients.

After the Council came into being, the facilities of some private offices and clinics were made available to potential technicians. Although this resulted in more and better training opportunities, no standard training course was offered until the "basic course" was organized in 1948. This consists of two months of intensive theory, and must be followed by 10 months of practical training under a certified orthoptic technician. Instructors are drawn from the ranks of leading ophthalmologists and technicians throughout the country for the basic course, and mimeographed notes are made available to the students.

Several leading teaching centers throughout the country offer a year's course of combined theoretic and practical training. Students who complete such a training course are fully qualified for the Council examinations.

Before beginning orthoptic training, a prospective student must fulfill the following requirements:

1. Applicants for training must be at least 18 years old and must present evidence of two years of college or comparable education or experience.

2. Applications for training must be accompanied by a letter of sponsorship signed by a practicing ophthalmologist approved by the Council.

3. Prior to training each applicant must present evidence of a satisfactory physical examination including a careful ophthalmologic examination by an ophthalmologist.

4. Training shall be carried out in schools, hospitals, and centers approved by the American Orthoptic Council or by instructors approved by the said Council.

5. Such training shall consist of theoretic instruction and its practical application, covering a minimum period of 12 months. In the practical training the use of actual clinical material under a certified orthoptic technician is mandatory.

6. Examinations shall be held only for qualified candidates who have made application, and shall be held at times and places designated by the Council. At least one examination shall be held each year. The examinations shall be written, oral, and practical. (Final application date and examination dates are announced in ophthalmic periodicals.)

7. An examination fee, the amount to be designated by the Council, shall be paid to the Council treasurer by each applicant. The examination fee at present is $30.00, and must be paid at the time of making application for examination. Unsuccessful candidates may be re-examined after further study without paying an additional fee.

8. The examiners shall be selected by the Council.

9. Candidates who successfully pass the examinations conducted by the Council shall be certified by the Council as proficient.

10. Certificates issued by the Council shall remain the property of the American Orthoptic Council subject to annual renewal, revocation, or return upon demand made by the Council. Applicants acknowledge the American Orthoptic Council's proprietary rights in these certificates and the limitations under which they are issued.

At present there are 337 certified technicians in the United States, of whom 205 are active. In Canada there are 32 certified technicians, of whom 18 are active. They are scattered throughout the country, although they tend to be concentrated in the larger cities. With the growing demand for their services, however, more and more technicians are entering areas previously without the benefits of orthoptics.

In conclusion, the point might well be

made that orthoptics alone seldom "cures" strabismus; rather, it is a step in, or portion of, the over-all program of treatment which includes correction of refractive errors, occlusion, and surgery. However, it is often a most important step.

References

Lancaster, W. B.: Duties and training of an orthoptic technician. Am. J. Ophth., **27**:5 (May) 1944.

———: What is orthoptics? J.A.M.A., **130**:407 (Feb. 16) 1946.

Scobee, R.: Orthoptics today. Am. Orthop. J., **1**:30; 1951.

Costenbader, F. D.: Orthoptic therapy. Am. Orthop. J., **3**:70; 1953.

———: Professional responsibility. Am. Orthop. J., **4**:60; 1954.

———: Training the orthoptic technician. Am. Orthop. J., **5**:135; 1955.

Adler, F. H.: Personal communication.

BOOK REVIEWS

Nursing in Diseases of the Eye, Ear, Nose, and Throat. From the Manhattan Eye, Ear, and Throat Hospital. Philadelphia, W. B. Saunders Company, 1958, edition 10. 269 pages, 83 figures, glossaries, index. Price: $4.50.

The fact that this useful manual has gone into 10 editions since the first in 1910 is an indication of its popularity and value. The ninth edition appeared in 1953 but newer information and techniques evolving in these fields in the last five years have necessitated a new edition. There are two parts. The first covers the eye and consists of 119 pages; the second covers the ear, nose, and throat.

The contributors are Drs. R. J. Bellucci, R. E. Beulieu, E. E. Faye, G. Frey, R. Townley Paton, W. F. Rabbett, F. H. Theodore and nurses, H. Emmett and E. K. Sullivan, members of the hospital staff. They have done a good job.

Part I, the eye, discusses the anatomy and physiology of the eye, instruments used in ophthalmic examination; the testing of vision; ocular motility problems; orthoptic training and blindness; external diseases, internal diseases; congenital defects; injuries and neoplasms. Chapters 7 and 8 have to do with ophthalmic nursing procedures (of particular interest to ophthalmologists) and chapter 9 is an excellent one on ocular therapeutics.

Part II, ear, nose, and throat, need not detain us here, although the chapters are well written, illustrated, and interesting even to the ophthalmologist.

The book is obviously prepared for the student nurse. There are stimulating questions at the end of each chapter, thought provoking even to the ophthalmologist. Those of us who have to do with the teaching of nurses, both student and graduates, will find it a most informative, instructive, and useful manual to use ourselves and to suggest to our classes. It is a fine gift to give to our scrub nurses, too. Highly recommended.

Derrick Vail.

Post-cure de l'Amblyope Rééduqué (Home Exercises for the Re-educated Amblyope). By Jean Sédan, M.D. Paris, Masson et Cie, 1958. 230 pages, 60 plates. Price: 3,500 fr.

After the ophthalmologist has obtained the best possible visual improvement in monocular functional amblyopia, such as occurs with strabismus and anisometropia, the results can be maintained and perhaps bettered by the many ingenious home exercises presented in this novel work. In some respects the book follows the pattern of that by Mildred Smith Evans, orthoptic technician at the Wilmer Institute. Her book, intended for the use of young children, was translated into French and is still highly popular.

Sédan's book, however, is designed for older children and young adults. Boredom and inattention are avoided by the intrinsic interest of the exercises and their extreme variety. The hunt for errors and the resolving of puzzles are dominant elements, as in

proof-reading incorrectly printed texts in types descending from 18 to 4-point, checking arithmetic miscalculations, detecting differences between apparently similar designs or photographs, and completing jig-saw patterns. Another device involves tracing on an overlying transparent sheet the dots of patterns of increasing complexity and then completing the designs. For the amblyopic eye with eccentric fixation, special patterns have been constructed to avoid confusion and eye-ear-hand co-ordination is utilized by instructing the patient to talk aloud while he points to the various letters and characters.

As the French have been intensely interested in the re-education of the functionally amblyopic eye since the time of Javal, it is odd that no mention is made of *The Amblyopia Reader* by Margaret Dobson of London, published about 20 years ago, which was printed in various sizes of black and red type and required the clipping of a ruby filter over the lens of the dominant eye.

An English adaptation of this book by Sédan would be a very worth-while project.

James E. Lebensohn.

Clinical Enzymology. Edited by Gustav J. Martin, Sc.D. Boston, Massachusetts. Little, Brown and Co., 1958. 241 pages, index. Price: $6.00.

It has become almost trite to state that the study of disease in man is the study of aberrations in enzyme systems. The list of such diseases is lengthened daily: diabetes, sickle-cell anemia, ochronosis, sprue, the vitamin deficiencies, adrenal diseases, and perhaps even cataracts.

Another aspect of the study of these organic catalysts is the use of enzymes for diagnosis and therapy. This book is concerned with this area of enzyme activity. The major emphasis is on the enzyme trypsin, with which the author is apparently most familiar. This may derive from his association with a large drug firm. Those interested in the use of trypsin to modify edema states in and about the eye will find well-documented instruction in Chapter 4 on the use of enzymes in medicine.

Dr. Martin is a provocative writer and feels compelled to defend the parenteral use of enzymes against detractors. One feels that he dismisses some of the evidence for anaphylactic reactions rather lightly and chastens his critics by referring to "intellectual atheromatosis and sclerosis." Other enzymes of possible interest to ophthalmologists discussed in this monograph are hyaluronidase, ribonuclease, chymotrypsin, and cholinesterase. For those less technically inclined the uninhibited philosophic meanderings of the author make stimulating reading.

David Shoch.

The Pharmacologic Principles of Medical Practice. By J. C. Krantz, Jr., and C. Jelleff Carr. Baltimore, Williams & Wilkins Company, 1958, edition 4. 1,285 pages, 59 illustrations, index. Price: $14.00.

The first edition of this justly popular work appeared in 1949 and went through four reprintings. The second edition appeared in 1951 with two reprintings; the third in 1954 with two reprintings. A Portuguese edition appeared in 1955, and a Spanish one in 1956. The reason for this popularity is readily understood, for the book is lucidly written and illustrated and eminently practical.

Ophthalmologists will find it of much value, although the short chapter on "Drugs in eye, ear, nose, and throat," is disappointing and incomplete from our viewpoint. It should be rewritten in the light of modern ophthalmic pharmacology and therapeutics. (For example, the old mercuric oxide ointment is still on the list and there is a thing called OpH Eye Lotion containing phenylephrine hydrochloride, zinc sulfate, and

boric acid which is given a good send off by the authors.) Let us hope that those physicians who are not ophthalmologists do not take this chapter too seriously but refer to recent ophthalmic literature instead.

Otherwise, and in spite of this, the book is fine and contains a wealth of readable information of much practical use for us in the broad field of pharmacology.

Derrick Vail.

THE PSYCHOLOGY OF MEDICAL PRACTICE. By Marc H. Hollender, M.D. Philadelphia, W. B. Saunders Company, 1958. 276 pages, bibliography and index. Price: $6.50

Perhaps some unfathomed mystic relation between ophthalmology and psychiatry, rather than coincidence, has caused a remarkable number of sons and brothers of ophthalmologists to enter psychiatry, while others, such as Schlaegel, have gone from psychiatry to ophthalmology. This volume by the son of A. R. Hollender, editor of *The Eye, Ear, Nose and Throat Monthly*, is written for the healing profession simply, clearly and without distracting psychiatric jargon. The author, who is chairman of the Department of Psychiatry at the State University of New York, gives a rational formulation of the art of medicine, which in the past was derived only from intuition and experience. The patient, who resents subconsciously the attitude of his physician, usually seeks another doctor more attuned to his current needs. When a patient turns to religion to ward off anxiety, depression, or fear, the physician's personal feelings about religion should not distort his evaluation of its significance for the patient.

A "check-up" visit cannot always be taken at face value. Asking for information in an open, frank, and casual manner will encourage a similar response. For most patients information about their illness is anxiety-relieving, but lengthy and complicated explanations should be avoided. Elective surgery should be discussed a week or more in advance so that patients may mobilize their inner resources for the ordeal. The procedure should be outlined so as to repress fearful fantasies. Co-operation without apprehension should be sought. It is certainly hazardous to tell a cataract patient: "If you make the slightest move during the operation, I cannot be responsible for the outcome." A running account of the technique, spoken in a matter-of-fact voice to the assistant provides assurance that the surgeon is master of the situation. Contrariwise, rambling chatter generates a sense of uneasiness.

Every ophthalmologist, young or old, but especially the young, will find this wise and mature text most helpful.

James E. Lebensohn.

ABSTRACT DEPARTMENT

EDITED BY DR. F. HERBERT HAESSLER

Abstracts are classified under the divisions listed below. It must be remembered that any given paper may belong to several divisions of ophthalmology, although here it is mentioned only in one. Not all of the headings will necessarily be found in any one issue of the Journal.

CLASSIFICATION

1. Anatomy, embryology, and comparative ophthalmology
2. General pathology, bacteriology, immunology
3. Vegetative physiology, biochemistry, pharmacology, toxicology
4. Physiologic optics, refraction, color vision
5. Diagnosis and therapy
6. Ocular motility
7. Conjunctiva, cornea, sclera
8. Uvea, sympathetic disease, aqueous
9. Glaucoma and ocular tension
10. Crystalline lens
11. Retina and vitreous
12. Optic nerve and chiasm
13. Neuro-ophthalmology
14. Eyeball, orbit, sinuses
15. Eyelids, lacrimal apparatus
16. Tumors
17. Injuries
18. Systemic disease and parasites
19. Congenital deformities, heredity
20. Hygiene, sociology, education, and history

2

GENERAL PATHOLOGY, BACTERIOLOGY, IMMUNOLOGY

Anderson, S. G. **The natural history of herpes simplex virus.** Tr. Ophth. Soc. Australia **17**:117-121, 1957.

The only known natural host of the herpes simplex virus is man. Primary infection is most common in the second and third years of life but can occur at any age. There is no clear evidence that recurrences are related to variations in the level of serum antibody. The physiology of latency of viruses and the factors precipitating clinical activity are poorly understood.

Ronald Lowe.

Colombi, Carlo. **The behavior of reactivated protein C in some ocular inflammatory processes.** Rassegna ital. d'ottal. **27**: 107-114, March-April, 1958.

It appears justifiable to assume that the prevailing negative reaction in the test for reactivated protein C is due to a lack of proper technique. More advanced technique may be able to show the presence of small quantities of the protein in the bloodstream. (1 table, 14 references)

E. M. Blake.

3

VEGETATIVE PHYSIOLOGY, BIOCHEMISTRY, PHARMACOLOGY, TOXICOLOGY

Bailliart, P. **Physiopathology of the retinal circulation.** Bull. mém. Soc. franç. d'opht. **70**:303-307, May, 1957.

The various factors determining the balance between humoral, cerebral and retinal circulation are reviewed and the specific character of the various kinds of arterial hypertension are discussed. It is emphasized that the basic concepts concerning retinal circulation have considerably changed during the last years; nevertheless the equilibrium between retinal and general arterial pressure always has been of great importance for prognosis and still is recognized as such.

Alice R. Deutsch.

Borello, Carlantonio. **The technique of thromboelastography applied to the aqueous of second formation.** Rassegna ital. d'ottal. **27**:47-50, Jan.-Feb., 1958.

The technique of producing tracings of the thromboelastic property of the aqueous of second formation is described. It follows the work on blood coagulation. The apparatus was designed to register

the photochemical tracings of coagulation and may be used with plasma or whole blood and aqueous of second formation. In the rabbit the latter is spontaneously coagulated and contributes to the rendering of the aqueous similar to plasma. (1 figure, 5 references) E. M. Blake.

De Conciliis, U. and Testa, M. **Thiaminase in the retina and the lens.** Rassegna ital. d'ottal. **27**:115-118, March-April, 1958.

The authors have studied the thiaminase activity in the retina and the crystalline lens of oxen, using a fluorometric method. The results have been negative. (9 references) E. M. Blake.

Del Pianto, E., Bozooni, F. and Valesini, G. A. **Experimental cataract from 1, 4-dimethylsulphonyloxybutane and the sulfuric content of the lens.** Boll. d'ocul. **37**:40-49, Jan., 1958.

The authors describe the characteristics of the lenticular changes found in rats. They found the total content of sulphydryl groups in the lenses of the rats was decreased in proportion to the extent and density of the opacities in the lens. When the opacity was total these groups were all but absent. (3 figures, 3 tables, 20 references) F. H. Haessler.

Tiberi, G. F. and Cuccagna, F. **Experimental diathermy coagulation of the sclera through the entire circumference of the globe.** Boll. d'ocul. **37**:123-132, Feb., 1958.

Experimental diathermy coagulation of the sclera of the eyes of dogs led to no untoward effects if it was limited to three quarters of the circumference of the sclera or if small gaps were left between areas of coagulation spread about the entire circumference. Complete blockage by a band of preequatorial coagulation resulted in hemorrhage, glaucoma and atrophy of the globe. (6 figures, 12 references) F. H. Haessler.

Vannini, Angelo. **The possibility of thrombo-elastographic research in some physio-pathologic conditions of the eye.** Rassegna ital. d'ottal. **27**:3-5, Jan.-Feb., 1958.

Recent experimental research has suggested the possibility of shedding light on the particular relationship existing between certain fluids and tissues of the eye and blood coagulation. The possibility of obtaining thrombo-elastographic tracings of human inflammatory aqueous in all its phases permits one to follow its course. It also allows the study of fibrinolysis. This work follows that of Jaeger. (2 figures, 12 references) E. M. Blake.

Verdi, G. P. **Histologic and pathogenetic study of experimental retinal lesions after naphthaline intoxication.** Boll. d'ocul. **37**:50-66, Jan., 1958.

Verdi describes his findings in histologic preparations of the retinas of rabbits which had been exposed to naphthaline poisoning. He found sharply delineated areas of necrosis in all strata of the retina and only a moderate number in the choroid. Reparative processes were slight. He doubts that the lesion is directly toxic in origin; it is more probably a degeneration which he ascribes to thrombosis in the smallest arteriolar branches. (8 figures, 49 references) F. H. Haessler.

4

PHYSIOLOGIC OPTICS, REFRACTION, COLOR VISION

Diamond, Stanley. **The effect of unilateral acquired myopia on depth perception in airline pilots.** J. Aviation Med. **29**: 468-474, June, 1958.

Increasing speeds of high performance aircraft require high degrees of stereoscopic acuity. Maximum stereopsis is dependent on excellent binocular visual acuity, and a decrease of vision in one or both

eyes may produce a decrease in stereopsis. The Howard-Dolman findings of five pilots were studied prior to and after the development of unilateral myopia. The findings illustrated that small degrees of unilateral visual loss (20/25 to 20/40) may cause a corresponding decrease in stereoscopic threshold. This was reflected as a one to three-fold loss in threshold of stereopsis based on parallax disparity. Periodic Howard-Dolman tests may reveal early and small decrements of depth perception in pilots who show decreased vision in one eye due to uncorrected acquired myopia. These pilots probably should wear corrective lenses for maximum stereopsis. (1 figure, 3 tables, 17 references) Author's summary.

Pasino, Luigi. **The value of the EEG in amblyopia.** Rassegna ital. d'ottal. **27**:119-129, March-April, 1958.

The author employed electroencephalography in the study of amblyopia but found that the complexity of the experiments yielded unsatisfactory results. The cases studied were mostly unilateral amblyopia. Intermittent light stimulation did not furnish sufficient elements to determine the existence of alterations of the optic pathways or the visual cortex. (4 figures, 26 references) E. M. Blake.

Raimondo, N. and Colombo-Bolla, M. **A statistical study of indirect astigmatism.** Boll. d'ocul. **37**:101-110, Feb., 1958.

The authors analyzed the refractive measurements of 25,000 ametropic subjects statistically. They present the data relating to indirect astigmatism (against the rule) in tables and graphs and discuss them in detail. Analysis of the form of the curve in indirect astigmatism related to age is the basis of an extensive discussion of the pathogenesis of this refractive state. (3 figures, 4 tables, 10 references) F. H. Haessler.

Vörösmarthy, D. **Studies of accommodation with Colenbrander's method.** Ophthalmologica **135**:58-65, Jan., 1958.

Colenbrander's method of measuring the amplitude of accommodation consists of determining the visual acuity on a Snellen chart (at 6 meters) through a minus lens held a few millimeters in front of the examinee's full distance acceptance. The minus lens should be approximately twice as strong as the expected amplitude of accommodation. The minus lens produces an upright, reduced, virtual image of the optotypes upon which the examinee accommodates. Since the minus lens is stronger than his amplitude of accommodation, his visual acuity through the minus lens (V′) is less than without the minus lens (V). The amplitude of accommodation is obtained by the formula $\frac{V'}{V} \times$ (strength of the minus lens). With this method the author has determined the amplitude of accommodation of 150 normal individuals of varying age and obtained somewhat smaller values than Duane. The relationship between age (x) and amplitude of accommodation (y) may be expressed by the formula $y = e^{-0.04797 \times +2.7652}$. (1 figure, 9 references) Peter C. Kronfeld.

5

DIAGNOSIS AND THERAPY

Bedell, A. J. **Some unusual fundus lesions.** Tr. Ophth. Soc. Australia **17**:23-27, 1957.

The author briefly discusses the following conditions: angioid streaks, angiomatosis retinae, hole at the macula, retinal cysts, and metastatic carcinoma in the choroid. Ronald Lowe.

Bosso, G. and Baccanini, P. **General anesthesia in ophthalmic surgery.** Rassegna ital. d'ottal. **27**:130-149, March-April, 1958.

The association of pentothal and cu-

rare, hyperoxidation and preliminary sedation gave a perfect combination for ocular surgery. This treatment was especially satisfactory in the intracapsular extraction of cataract by the suction method. The ages of patients varied from seven to 83 years and no complications in cardiac or pulmonary lesions occurred. A striking feature was the "silence" of the vitreous body. (3 figures, 39 references)

E. M. Blake.

Burlakova, T. **The etiology of iridocyclitis.** Vesnik oftal. 1:26-28, Jan.-Feb., 1958.

Following older German writers the author studied 564 patients with iridocyclitis between 1946 and 1956. Her findings with respect to the etiologic factors were as follows: tuberculosis 42.5 percent, rheumatism 23 percent, grippe and other virus conditions 6 percent, dental conditions 4 percent, conditions of disordered metabolism 1 percent, and unknown causes 22.5 percent. She noted the uncertainty which is attached to conclusions as to a tuberculous etiology, as well as the fact that toxoplasmosis is lately coming to be considered of greater importance.

Victor Goodside.

Colombi, Carlo. **Ophthalmoscopic observations with a variable monochromatic light.** Rassegna ital. d'ottal. 27:39-46, Jan.-Feb., 1958.

The use of rays of special portions of the visible spectrum in the past hundred years is reviewed. In 1937 Kugelberg devised a monochromatic lighting instrument, and shortly afterward Hultin and Kornerup produced a new apparatus using a series of filters and making possible the examination of the fundus with monochromatic light. The latter is adaptable to biomicroscopy and makes possible clearer definition than with regular light. (2 figures, 17 references) E. M. Blake.

Darvall, R. **External ocular conditions associated with hormonal dysfunction.** Tr. Ophth. Soc. Australia 17:42-47, 1957.

Many external ocular conditions may be associated with the menstrual cycle or its dysfunction, surgical removal of the ovaries or their involution. Eye drops containing sex hormones were used to treat the following conditions: recurrent keratitis, recurrent periodic episcleritis, keratoconjunctivitis sicca, senile corneal dystrophies. Different eye drops are described. The results are interesting but inconclusive. Ronald Lowe.

Gandolfi, A. **A new procedure in plastic surgery of the lower fornix.** Boll. d'ocul. 37:111-116, Feb., 1958.

The author's modifications of Maxwell's operation is easy to perform and led to satisfactory results in two patients. (4 figures.) F. H. Haessler.

Kuhn, H. S. **Ophthalmic screening procedures.** Tr. Ophth. Soc. Australia 17:106-110, 1957.

The establishment of techniques for mass visual testing has been a conspicuous advance in industrial eye programs. The use of various devices is briefly described. Ronald Lowe.

Lamb, A. **A clinical trial of human hair as suture material in eye surgery.** Tr. Ophth. Soc. Australia 17:48-56, 1957.

Human hair is a suitable material for suturing the human cornea because of its tissue inertness, ready availability and simple sterilization. It is atraumatic, visible, and easy to handle. Ronald Lowe.

Rokitskaya, L. V. **Oxygen therapy in disturbances of dark adaptation in patients with hypertensive vascular disease.** Vestnik oftal. 1:28-38, Jan.-Feb., 1958.

A single subconjunctival injection of oxygen sufficient to produce swelling of

about one half of the corneal periphery was given to eight patients with hypertensive vascular disease. Examination with the adaptometer before and after injection revealed an improvement in light sensitivity in the dark adapted eye. This was considered evidence of improved oxygenation in a retina deficient in oxygen because of circulatory impairment in hypertensive vascular disease.

A systematic course of oxygen therapy given subconjunctivally (15 to 20 times) and subcutaneously (300 to 500 cc.) was given to 18 patients of whom 13 showed increase in visual acuity, widening of the visual field, increased absorption of the retinal hemorrhages, which are seen in patients with partial thrombosis of the central retinal vein, angioretinopathy, and neuroretinopathy. Victor Goodside.

Scassellati Sporzolini, G. and Fiorini, G. **Salicylate of soda in experimental ophthalmology.** Rassegna ital. d'ottal. **27**:51-42, Jan.-Feb., 1958.

Sodium salicylate was employed locally in the form of drops or ointment in the treatment of superficial injuries to the cornea with success. In perforating injuries with the formation of a connective tissue plug it is not effective but in the phase of new-formation of connective tissue and epithelium the repair is markedly accelerated. The results of salicylate treatment parallel the treatment with cortisone and its derivatives. (10 figures)

E. M. Blake.

Schrader, K.-E. and Weber, W. **The influence of prolonged estrogen administration upon the growth of a chromophobe pituitary adenoma.** Ophthalmologica **135**: 44-50, Jan., 1958.

The report concerns a young woman in whom the treatment of amenorrhea with estradiol caused, at first, transient and mild visual impairment. After two injections of 10 mg. of estradiol the patient developed severe headaches and complete loss of vision. Ophthalmologic and roentgenologic examination at that time revealed a far advanced pituitary tumor, the growth of which had apparently been accelerated by the hormone therapy. After partial extirpation of the tumor the patient lapsed into a state of complete decerebration with hyperthermia and died on the second postoperative day. (2 figures, 11 references) Peter C. Kronfeld.

Scuderi, G. and Cardia, L. **Local therapy with a sulfonamide in chronic conjunctivitis and as a prophylactic before surgery.** Boll. d'ocul. **37**:117-122, Feb., 1958.

The authors found the local application of sodium sulphacetamide entirely satisfactory in 30 patients with chronic conjunctivitis which was resistant to the commonly used antibiotics. It was also useful for prophylaxis before surgery in 20 patients. (12 references)

F. H. Haessler.

6

OCULAR MOTILITY

Costenbader, F. D. **Principles of treatment of accommodative esotropia.** Tr. Am. Acad. Ophth. **61**:390-396. May-June, 1957.

The author is very definite in the treatment which consists of reinstatement of binocular alignment and binocular vision by the immediate use of glasses, bifocals, miotics, or surgery, and a continuing effort to maintain parallelism. If anisometropia exists, occlusion and active visual stimulation is indicated. He discusses accommodative esotropia with a normal A/C relationship and with an abnormal relationship. (1 figure).

Theodore M. Shapira.

7

CONJUNCTIVA, CORNEA, SCLERA

English, P. B. and McGuiness, E. F. **Bengal rose staining in Queensland ker-**

ato-conjunctivitis. Tr. Ophth. Soc. Australia 17:110-117, 1957.

In Queensland a number of patients complain of sore, aching eyes, sensitivity to glare and conjunctival irritation, with exacerbations and remissions. With Bengal rose the conjunctiva shows staining of various intensity. The cause is unknown; it is thought not to be drying, possibly it may be due to ultraviolet light.

Ronald Lowe.

Evans, P. J. **The therapeutic value of keratoplasty in dendriform and metaherpetic ulceration of the cornea.** Tr. Ophth. Soc. Australia 17:123-129, 1957.

An analysis is given of 40 therapeutic grafts, 21 of which were for dendritic or disciform ulceration, 13 were planned for visual recovery and eight were tectonic. Fourteen grafts were clear and 17 gave better vision. Ronald Lowe.

François, J., Rabaey, M. and Evans, L. **Melanotic tumors of the bulbar conjunctiva.** Ophthalmologica **135**:1-21, Jan., 1958.

The results of the clinical and histologic findings in 18 cases of melanotic tumor of the bulbar conjunctiva are reported. Five entities could be recognized: the benign congenital melanosis, the nevus, the nevocarcinoma, the acquired precancerous and the cancerous melanosis.. A. B. Reese's classification of pigmented tumors of the conjunctiva was confirmed. (26 figures, 32 references) Peter C. Kronfeld.

Greer, C. H. **Carcinoma of the conjunctiva.** Tr. Ophth. Soc. Australia 17:64-67, 1957.

This brief paper describes carcinomata which arise in the surface epithelium of the conjunctiva, from which they are derived. Three types of carcinoma occur: 1. basal-cell carcinoma, 2. squamous cell carcinoma or epithelioma, and 3. melanocarcinoma or malignant melanoma of the conjunctiva. The intraepithelial phase may be very brief or may be long.

Ronald Lowe.

Mohsenine, H. and Darougar, S. **The provocative effect of cortisone on trachoma.** Rev. intern. du trachome **34**:336-348, 1957.

Studies on 25 trachoma patients for three to 10 months disclosed that cortisone is a very useful means for activation of inactive cases. Trachoma inclusions were seen in 16 patients. In all of them cytologic changes, such as Leber cells, degenerated cells, mitotic and pigmented cells, and clinical symptoms, for example, congestion, photophobia, secretion, and papillae, were observed. (5 figures, 2 tables, 8 references)

Jose A. Ferreira.

Nakajima, A. and Otake, T. **Studies on trachoma.** Rev. intern. du trachome **34**: 398-437, 1957.

The conjunctival smears taken in various stages of trachoma and epidemic keratoconjunctivitis, measles conjunctivitis and bacterial conjunctivitis are described in detail from a cytochemical point of view and their differences are emphasized. The hematologic and serum protein fraction studies of the stages of trachoma are presented as systemic manifestations of the disease. Finally the epidemiology in adults and children is given. (33 figures, 5 tables, 19 references)

Jose A. Ferreira.

Redmond, K. B. **Keratoconus with particular reference to the use of microcorneal lenses in its treatment.** Tr. Ophth. Soc. Australia 17:85-98, 1957.

The author reviews in detail 42 patients with keratoconus, ten of whom were fitted with microcorneal lenses.

Ronald Lowe.

Smati, A. **Ophthalmic teams in Algeria.** Rev. intern. du trachome **34**:468-497, 1957.

The ophthalmic teams pursue the following aims: detection and antitrachoma and anticonjunctivitis campaigns. Descriptions of the results from 1952 to 1954 are compared with those of 1955. (4 figures, 18 tables) Jose A. Ferreira.

Strampelli, B. **Results after 10 years of implantation of Stensen's duct into the conjunctival sac of an eye with xerophthalmos.** Boll. d'ocul. **37**:89-100, Feb., 1958.

Stensen's duct had been transplanted into the conjunctival sac in a patient with a xerophthalmos 10 years ago. The author describes his procedure in detail and discusses the results. Saliva which is secreted during movements of mastication is still discharged into the conjunctival sac but the xerophthalmos remains unchanged. (17 figures, 12 references) F. H. Haessler.

Torfeh, H. **Treatment of trachoma in Iran.** Rev. intern. du trachome **34**:439-451, 1957.

After a critical description of the modern treatment of trachoma, the author points out that sulfonamides and chloromycetin give the best and fastest results. (8 tables, 3 references) Jose A. Ferreira.

Tunekazu Yuge. **A possible conception of trachoma allergy.** Rev. intern. du trachome **34**:498-504, 1957.

The author presents his own conception of a possible allergic factor in trachoma based on antibody formation and the histopathologic picture. He considers the origin of the recurrences, treatment and prophylaxis as well as trachoma without virus. (24 references) Jose A. Ferreira.

Vellieux, M. **Present data about the etiology, epidemiology and treatment of trachoma and epidemic conjunctivitides.** Rev. intern du trachome **34**:383-397, 1957.

A summary is presented of the world distribution and clinical manifestations of trachoma and of the differential diagnosis between trachoma in the early stage and other types of epidemic conjunctivitides. The author emphasizes the importance of the environment and superimposed infections. The mass and individual treatment applied in French West Africa is outlined. Jose A. Ferreira.

8

UVEA, SYMPATHETIC DISEASE, AQUEOUS

Agarwal, Lalit P. **Valvular, post-placed iridencleisis.** Ophthalmologica **135**:51-57, Jan., 1958.

The results of 386 iridencleises for primary glaucoma are reported. The salient features of the author's technique are: a full-thickness, limbus-based epibulbar tissue flap, a rather complicated keratome incision which is started by scratching through the outer half of the sclera (at right angles to the surface of the globe) at 4 mm. from the limbus, then continued intralamellarly to about 1 mm. from the limbus and completed by dipping the tip of the keratome into the chamber angle. The iris is brought into the external part of the wound by means of forceps and incised radially. Only one iris pillar is incarcerated. The term "post-placed" refers to the far posterior site of the iris inclusion. "Good" or "adequate" drainage was obtained in 315 of the 335 eyes that could be observed postoperatively for a reasonable length of time. (4 tables, 12 references) Peter C. Kronfeld.

Falcinelli, C. **Free pseudocysts in the anterior chamber.** Boll. d'ocul. **37**:67-70, Jan., 1958.

The author points out that a pseudocyst in the anterior chamber is not always in-

nocuous and describes the development of chronic glaucoma secondary to a pseudocyst in the anterior chamber which was formed by a small mass of ophthalmic ointment. (6 references)

F. H. Haessler.

Heer, Giuseppe. **Acquired ectropion uveae in hemorrhagic glaucoma.** Rassegna ital. d'ottal. **27**:54-106, March-April, 1958.

Among the pathogenetic factors involved in the production of ectropion uveae is an exudation at the level of the anterior uvea and a total closure of the irido-corneal angle. Added to these factors is a hyperplasia of the pigment epithelium and atrophy of the iris. The author has studied histologically 12 cases of rubeosis iridis diabetica, 11 of hemorrhagic glaucoma due to diabetes and four secondary to the glaucoma due to thrombosis of the central retinal vein. (6 figures, 59 references) E. M. Blake.

Ricci, L. **Therapy of chorioretinal lesions due to hypoxia with oxygen vasodilators.** Boll. d'ocul. **37**:133-142, Feb., 1958.

Therapy with oxygen and vasodilators was effective in 70 patients in whom chorioretinal hypoxia followed the gradual obliteration of capillaries. The critical factor is the phase of degeneration of the retinal cell. (5 references)

F. H. Haessler.

9

GLAUCOMA AND OCULAR TENSION

Duke-Elder, Stewart. **The aetiology of closed angle glaucoma.** Tr. Ophth. Soc. Australia **17**:12-23, 1957.

For the etiology of closed angle glaucoma, not only the eye but also the central control of its basic functions, must be considered. The first prerequisite is a narrow angle of the anterior chamber which is frequently inherited as a dominant characteristic. The second prerequisite is an unstable vasomotor mechanism characterized by alternating phases of vasoconstriction and vasodilatation in the uvea leading to a bellying forward of the iris, a block of the exit channels and a further rise of tension. In the congestive phase the aqueous contains a histamine-like substance and the whole eye is edematous. The behavior resembles a kind of acute shock. The red congestion is due to tissue damage and the eye with raised pressure is in a completely different state from one with raised tension due to vasoconstriction typical of the diurnal variation. If performed sufficiently early, a peripheral iridectomy renders the eye safe for life. Ronald Lowe.

Heer, Giuseppe. **The character of the tonometric curve in diabetic rubeosis iridis and in hemorrhagic glaucoma.** Rassegna ital. d'ottal. **27**:26-31, Jan.-Feb., 1958.

The author recognizes four classes of ocular hypertension. Group I is composed of patients affected by retinopathy, but free of rubeosis iridis. Patients in group II had rubeosis but normal intraocular pressure, in Group III they had rubeosis with increased pressure, and in Group IV hemorrhagic glaucoma secondary to diabetic rubeosis or thrombosis of the central retinal vein, in which the iris angle was completely closed. Charting of the intraocular pressure curves for eight days illustrates the four classes. (3 figures, 20 references) E. M. Blake.

Martins Rocha, H., De Rezende, C. and Munoz-Salgado, L., Trujillo, F., Posada Fonseco, A., and Hernandez, R. **Symposium: Secondary glaucoma.** Tr. Fifth Pan Am. Cong. Ophth. Santiago **1**:271-342, 1956.

Martins Rocha, H. **Etiology.** pp. 271-272.

The writer considers secondary glaucoma in the acute and chronic intraocular inflammations, and hypertensions caused

by the sequels of these inflammations, "post-inflammatory glaucoma."

Traumatism is also considered in the etiology of secondary glaucoma, including glaucoma produced by ocular contusion, penetrating wounds and as a complication in ocular surgery, especially in different forms of cataract extraction. Through the occlusion of the pupil, secondary glaucoma appears when the shape and growth of the lens are altered, thereby obstructing the way between the anterior and posterior chambers.

A luxated lens, acting as an irritative agent on the ciliary body or by the way in which the iridocorneal angle is affected through the iris, is equally a cause of hypertension. Other etiologic factors are: intumescence of the lens and the irritating action of substances produced by a Morganian cataract. Desquamation of the lens capsule produces Vogt's capsular glaucoma. Atrophic or sclerotic conditions of the iris, choroid and retina, vascular alterations of the retina (as in the case of hemorrhagic retrolental fibroplasia) are also causes of secondary glaucoma. Finally, intraocular tumors, retinal detachments, obstruction of the orbital veins and epidemic hydrops can be etiologic factors.

De Rezende, C. and Munoz-Salgado, L. **Gonioscopy.** pp. 273-300.

Gonioscopy is most useful in glaucoma secondary to infections of the eye, postoperative glaucoma, glaucoma due to alterations of the lens, traumatic glaucoma, and glaucoma caused by intraocular tumors.

In a second group, rare secondary glaucomas are discussed in which gonioscopy is of very little value (glaucoma due to retroöcular obstacles in venous circulation, to choroidal angioma, to progressive essential atrophy of the iris, and to old retinal detachments and retrolental fibroplasia, for example). Gonioscopy in infections of the anterior segment of the eye helps to differentiate whether they develop in open or narrow angle. Trabecular blocking through the iris base or formation of peripheral synechiae due to sustained atropine treatment, mainly in eyes with narrow angles, might be avoided by this differentiation.

In acute hypertensive uveitis alterations of the angle do not necessarily suggest trabecular obstructions. In the genesis of hypertension much importance is given to the participation of the related ciliary epithelium, whose functions have been affected by the infectious process.

In subacute and chronic uveitis, the obstructive factor at the angle and the secretory factor of the ciliary processes are equally important. In healed or cicatriced uveitis the hypertension is mainly due to peripheral synechiae, and alterations in the production of aqueous humor are of minor importance. In postoperative glaucoma the different mechanisms which might cause hypertension are analyzed, and the gonioscopic aspect of the complications which might produce secondary glaucoma are described (preoperative glaucoma, postoperative uveitis, flat chamber incarceration of tissues, loss of vitreous, epithelization of the anterior chamber, operative hemorrhage, and air in the anterior chamber).

The postoperative use of mydriatics must be absolutely avoided, especially before the anterior chamber has been refilled. Analysis of various statistical studies of the postoperative complications leads the authors to conclude that postoperative failures are mainly due to lack of precautions and ability on the part of the surgeon. The technique itself is of minor importance. The authors describe the effects of alterations of the lens and their effects—luxations and subluxations, spherophakia, intumescent cataract, phakolytic glaucoma, phakoanaphylactic glaucoma, capsular breaks and finally the so-called capsular glaucoma. In these types of glaucoma it is important to consider

the alterations undergone by the structure of the lens capsule which helps to establish a contact between intracapsular proteins and ocular humors, thereby expediting the intumescence of the lens or the production of phakoanaphylactic endophthalmitis. Secondary hypertension may frequently be ascribed to these circumstances. The authors describe the gonioscopic picture in hemorrhagic pigmentary glaucoma secondary to intraocular tumors, obstruction of the returning venous circulation, choroidal angiomas, progressive essential atrophy of the iris, Bengal glaucoma and others. (163 references)

Trupillo, Fortunato. **Differential diagnosis.** pp. 301-309.

There are several glaucomas, both primary and secondary, which are difficult to classify. Examples are: aphakic glaucoma in which a presurgical glaucomatous condition is aggrevated by the surgery, thus superimposing a primary glaucoma and a secondary one and postoperative glaucoma due to delayed formation of the anterior chamber in which the increase in pressure is directly proportional to the amount of goniosynechiae. In some cases of the thrombosis of the central retinal vein a pre-existing decreased facility of outflow seems to reverse the cause and effect sequence, indicating that thrombosis can occur in some instances as a result of a mild glaucoma. Dvorak-Theobald's studies show that in glaucoma capsularis there is a pseudoexfoliation of the capsule; the debris in the chamber angle consists of an unknown granular substance and not of true cells from the lens capsule. In the phakolytic type of glaucoma following a hypermature cataract, rupture of the lens capsule is not necessary as the degenerative changes of the capsule are enough to render it permeable. The author proposes the inclusion of chronic congestive glaucoma (closed angle type glaucoma) with the secondary glaucomas since this type evolves from a primary narrow-angle glaucoma improperly treated. This type of glaucoma is bound to disappear with the accessibility of modern theraputic means to avert the hypertensive crisis, and it is probable that in the future the finding of this condition will be proof of therapeutic negligence. (17 references)

Posada Fonseca, Alejandro. **Medical treatment.** pp. 311-332.

Successful medical treatment requires a full evaluation and understanding of the anatomic and physiologic condition of the eye. In acute cyclitis and iridocyclitis mydriatics should be used with Diamox and the dosage must be adjusted on the basis of repeated tonometric measurements. Pilocarpine, eserine and D.F.P. are indicated in mechanical blockage of the chamber angle. Adrenalin, Levoglaucosan and Diamox have a better action in open angle secondary glaucoma. Diamox is always useful in secondary glaucomas when associated either with miotics or mydriatics as the case may require. In recent cases of hypertensive uveitis the author has used cortisone, subconjunctivally or topically, associated with Diamox; the results have been satisfactory and in these instances cortisone seems to have a hypotensive effect. ACTH increases ocular tension in uveitis and is therefore less valuable. In diabetic hypertensions cortisone is contraindicated. Retrobulbar injection of alcohol is indicated in acute hypertensive stages and together with Diamox is valuable preoperatively.

In a study of twenty-two patients with secondary glaucoma failures were observed in central retinal vein thrombosis, diabetes, and chronic uveitis. Fourteen patients received Diamox (500-1000 mgs. daily), alone or combined with miotics, with good results. Cortisone and D.F.P. proved to be good hypotensors alone but less effective when combined with Diamox. (1 table, 16 references)

Hernandez, Rodolfo. **Surgical treatment.** pp. 333-342.

In glaucoma secondary to inflammatory conditions, consideration should be given to the different phases of the disease at the time a surgical procedure is decided upon. Acute phases benefit from repeated paracentesis, iridencleisis and diathermy in this order of preference, and Elliot's trephine, Larange sclerectomy and cyclodialisis should be avoided.

In subacute and chronic stages the presence of pupillary synechiae or goniosynechiae is a factor in the choice of procedure. Large iridectomies are advised when the pupil is partially bound down. In corneal ulcers with hypopion and hypertension, repeated paracenteses are advised because the eye benefits from the hypotension and from the increased amount of antibodies in the secondary aqueous. Secondary glaucoma due to a dislocated lens usually responds to lens extraction alone, but in posterior dislocations there is great operative risk; cyclodiathermy is advisable prior to the operation. In secondary glaucoma due to exfoliation of the anterior lens capsule best results follow lens extraction and large iridectomy if the lens is opaque; if the lens is clear any filtering procedure will be adequate. Trephine operations and iridencleisis give rise to a large percentage of secondary cataracts.

If glaucoma develops after cataract extraction and the lens has been removed in toto, a conservative approach should be taken for as a rule the hypertension is transient. If the operation was extracapsular, an attempt should be made to wash out the lens debris as much as possible. If the cataract has been removed through a large iridectomy and the iris pillars are adherent to the posterior corneal surface, Elliott's trephine and cyclodialysis are indicated. The author's choice would be cyclodialysis or cyclodiathermy. Iridencleisis has been little practiced in these cases but the results obtained have been most encouraging. In pupillary seclusion the choice of operation is a total iridectomy or two small peripheral ones.

Hemorrhagic glaucoma still is almost hopeless. Paracentesis of the anterior chamber is contraindicated. Cycodiathermy has been tried with uneven results and Amsler has advised roentgen therapy, 300 to 500 units in three to five treatments.

Traumatic secondary glaucoma has no therapy of choice, surgical handling is closely related to and as variable as the extent and localization of the injury.

For secondary glaucoma due to trauma or neoplasm there is no specific treatment and in most instances the eye soon must be enucleated. (62 references)

G. Scioville-Samper.

Varfolemeev, V. P. **Intravenous injection of novocaine in an acute attack of glaucoma.** Vestnik oftal. 1:54-55, Jan.-Feb., 1958.

The author noted that intravenous novocaine used in 120 patients with keratitis, iritis, and iridocyclitis produced alleviation of the symptoms and lowering of the ocular tension. This treatment was administered to five patients with acute attacks of glaucoma not responsive to the usual antiglaucoma therapy energetically applied. Two of these patients had secondary glaucoma, and three had acute exacerbations of chronic glaucoma. The novocain was administered intravenously in 1-percent solution in normal saline, and given in a single dose of 40 to 80 cc. at a rate of 3 cc. per minute. In each case the tension was lowered to normal levels within a period of one to four days and the pain promptly improved or disappeared, and sleep or near sleep was induced.

Victor Goodside.

Weinstein, P. **Nervism in ophthalmology: data concerning the neurotherapy of glaucoma.** Ophthalmologica 135:21-44, Jan., 1958.

In prodromal, presumably angle-closure, glaucoma the author reports beneficial results with forms of treatment acting on the nervous centers which are thought to control the intraocular pressure. These therapeutic measures include 1. extraneous sex hormone to inhibit the function of the anterior lobe of the pituitary, 2. X-ray treatment directed at the diencephalon, and 3. ganglionic blocking agents. Eserine and the iridectomy may lower the pressure partly through action upon the ciliary ganglion. (3 figures, 5 tables, 146 references)

Peter C. Kronfeld.

10

CRYSTALLINE LENS

Garzino, Alessandro. **Free lentoid bodies following surgery for congenital cataract.** Rassegna ital. d'ottal. **27**:81-93, March-April, 1958.

The patient described was operated upon for bilateral congenital cataract at the age of 29 years. Discission was performed twice on each eye and after absorption of the lens material great numbers of spherical, translucent bodies were observed on the remnants of the lens capsule and especially in the iridocorneal angle. A Soemmering ring was also present. The scanty literature is reviewed. (4 figures, 181 references)

E. M. Blake.

11

RETINA AND VITREOUS

Bedell, A. J., **Blood vessel changes in the ocular fundus.** Tr. Ophth. Soc. Australia **17**:37-42 1957.

The following condtions are briefly reviewed: hypertension, embolism, endarteritis, spasm, thrombosis, and diabetes.

Ronald Lowe.

Bignell, J. L. **Modern concepts in diabetic retinopathy.** Tr. Ophth. Soc. Australia **17**:58-60, 1957.

Recurrent hemorrhages are due to the bursting of new-formed capillaries. The hemorrhages can be prevented by 1. a regulated life avoiding venous congestion or raised arterial pressure, and 2. repeated small doses of X-rays.

Ronald Lowe.

Campbell, K. **The incidence of retrolental fibroplasia in premature infants with controlled oxygen therapy.** Tr. Ophth. Soc. Australia **17**:81-84, 1957.

In an institution where previously a large amount of oxygen had been employed, the incidence of retrolental fibroplasia dropped from 18.7 percent to 0.8 percent. In a second institution where previously a moderate amount of oxygen had been employed the incidence dropped from 7 percent to 0.8 percent.

For oxygen administration one cannot state an upper limit which must not be exceeded. The suggested upper limit of four liters per minute may be entirely inadequate in gross cases of atelectasis and if more is not given the infant will die. The baby should be given only the necessary minimum. The only clinical criterion is the baby's color; disease causing cyanosis should be prevented when possible.

Ronald Lowe.

Kurrle, G. **Radiotherapy and diabetic retinitis.** Tr. Ophth. Soc. Australia **17**:61-63, 1957.

The doses were not large, ranging from 600 r in three weeks to 1500 r in ten weeks. The technique of using temporal ports is described.

Ronald Lowe.

Reese, A. B., Hyman, G. A., Merriam, G. R. Jr. and Forrest, A. W. **The treatment of retinoblastoma by radiation and triethylene melamine.** Tr. Am. Acad. Ophth. **61**:439-446, July-Aug., 1957.

The authors report 57 cases of retinoblastoma treated since January, 1953 by

means of a combination of X-ray therapy and TEM. Twenty of these cases are compared with 22 cases given X-ray alone. On the basis of their studies the authors state: 1. that treatment by a combination of X-ray therapy and TEM is more effective than X-ray therapy alone, 2. TEM intramuscularly is more effective than orally, 3. the lower doses of X-ray therapy employed in combination lead to no vitreous hemorrhages and 4. visual results are better, and cosmetic deformities are negligible. (8 figures, 7 references)

Theodore M. Shapira.

Sebestyén, J. **Diffuse familial chorioretinal atrophies.** Szemeszet **2**:62-68, 1958.

After reviewing the problem of the diffuse, familial chorioretinal atrophies in general, two cases of this type are described, complicated by calcifying cataract and regarded by the author as atrophia gyrata chorioideae et retinae. It is assumed that the cataract formation and the calcification are each caused by embryonic damage to the crystalline lens as well as by local metabolic and circulatory disturbances. The author supposes that these cases belong to the neuro-ophthalmic syndromes. Gyula Lugossy.

Streiff, E. B. **Retinal arteritis and chronic degenerative polyarthritis.** Bull. mém. Soc. franç. d'opht. **70**:405-410, 1957.

Iridocyclitis, scleritis, keratitis and optic neuritis are ocular diseases frequently associated with rheumatoid arthritis. A primary affliction of the retinal arteries is very rare indeed and only one case had been reported in the French literature while two cases were mentioned in a survey of 77 cases of ocular complications of chronic polyarthritis in the English language. A 45-year-old woman, incapacitated with rheumatoid arthritis (Charcot) developed a retinal arteritis in her left eye with temporary papilledema, congestion of veins, and spotty yellowish localized deposits. Delicate nodular deposits in the arterial walls disappeared slowly, leaving a fine veil on the arterial surface. Clinically and biologically these were manifestations of an inflammatory disease involving the retinal arteries. The sudden appearance and complete clinical and functional recovery resembled an allergic angiitis and might be evaluated as a mild variety of the otherwise more serious chronic arterial changes in the various collagen diseases. Systematic inspections of the fundi in patients with rheumatoid arthritis are recommended to clarify this clinical problem.

Alice R. Deutsch.

12

OPTIC NERVE AND CHIASM

Rubinstein, Kazimierz. **Endothelioma of the optic nerve.** Brit. J. Ophth. **42**:367-369, June, 1958.

Monocular blindness in a 36-year-old woman is reported. It had been previously diagnosed as the result of central retinal vein thrombosis. Now there was a chalky whiteness of the papilla with a peculiar type of glial overgrowth, a slight degree of proptosis, and compressibility of the globe. During enucleation a neoplastic infiltration of the distal end of the stump was found which necessitated a neurosurgical procedure for adequate resection of the nerve. Microscopic sections revealed an endothelioma which had invaded the optic nerve into the anterior part of the optic canal. Stiffening of the nerve by this infiltration destroyed the normal curvature and brought about a slight proptosis. (4 figures, 2 references)

Lawrence L. Garner.

Venturi, G. and Andreani, D. **Vascular pseudopapillitis.** Ressegna ital. d'ottal. **27**:6-25, Jan.-Feb., 1958.

Unilateral or bilateral compression of

the optic nerve can occur in patients with arteriosclerosis, hypertension, temporal arteritis or other systemic disease. The authors present three cases in which there was a suggested diagnosis of vascular pseudopapillitis. The cases in question concerned three arteriosclerotics, two without hypertension and one hypertensive, in which an acute papillitis, bilateral in one case and unilateral in two, developed. Atrophy of the nerve with central or peripheral field changes followed. (2 figures, 38 references)

E. M. Blake.

13

NEURO-OPHTHALMOLOGY

Alemà, G. and Vanni, V. **Syndrome of Parinaud as a sequel of frontal tumor.** Boll. d'ocul **37**:32-39, Jan., 1958.

The authors describe clinically and pathologically a tumor of the right frontal lobe. Anterior and posterior herniation of the temporal lobes led to injury of the left oculomotor nerve with paralysis of upward gaze and of convergence, which were accompanied by a hemiparetic syndrome on the left side and isolated peripheral defects of the facial nerve. 4 figures, 8 references)

F. H. Haessler.

Falconer, M. A. and Wilson, J. L. **Visual field changes following anterior temporal lobectomy: their significance in relation to "Meyer's loop" of the optic radiation.** Brain **81**:1-14, 1958.

Visual field changes were studied in 50 consecutive epileptic patients treated by anterior temporal lobectomy. The extent of the resection varied from 4.5 to 9 cm. measured from the temporal pole, and in all cases the tip of the temporal horn of the ventricle was opened. A congruous homonymous field defect contralateral to the side of the surgery was always found. These defects varied greatly in extent from the smallest upper homonymous sector defects to complete hemianopsia, which occurred in two cases. The sector defects always were adjacent to the upper vertical meridian and as the severity of the hemianopia increased the defects spread in a sector-shaped area toward the horizontal meridian. In the more marked degree of hemianopia the loss extended downward below the horizontal meridian sectorwise towards the lower vertical meridian. In all cases the macular region was spared. With excision of less than 8 cm. no constant, direct relationship was found between the size of the field defect and the amount of temporal lobe removed. However, in those cases in which more than 8 cm. was removed there was a much greater incidence of hemianopsia involving more than one quadrant.

These findings support Meyer's view that the lowermost fibers of the optic radiations loop around the tip of the temporal horn. The strict congruity of the defects is at variance with the prevailing view that lesions in this area produce incongruous homonymous field defects. (7 figures, 2 tables, 17 references)

William S. Hagler.

Van Buren, J. M. and Baldwin, M. **The architecture of the optic radiation in the temporal lobe of man.** Brain **81**:15-40, 1958.

The central and peripheral visual fields were carefully studied in 41 patients who had unilateral temporal lobectomies for epilepsy. As would be expected, neither the visual acuity nor the size of the blind spots was changed by the surgical procedure. In five cases there were no detectible field changes even though the tip of the temporal horn of the lateral ventricle and its surrounding white substance was removed in every case. In the remaining cases contralateral homonymous upper quadrantic defects of variable size were produced. In ten of these the defects

were strictly congruous, whereas in the rest they were incongruous with the larger defect on the side of the lesion. The superior margins were always along the vertical meridian and were steep, whereas the inferior margins were usually sloping and often extended below the horizontal meridian.

Because of these findings the authors feel that fibers from adjacent retinal elements are spatially separated in the optic radiations and the representations of the upper and lower visual quadrants in the optic radiations are not separated by macular fibers. In the anterior portions of the radiations the representation of the ipsilateral and contralateral retinal halves extends an equal distance anteriorly, but the ipsilateral retinal representation lies lateral to the contralateral retinal representation. (13 figures, 41 references)

William S. Hagler.

14

EYEBALL, ORBIT, SINUSES

Lagrot, F., Py, N., Alcayde, M. and Lavergne, E. **Restoration of orbital sockets and conjunctival cul-de-sacs.** Arch. d'opht. **17**:769-781, Dec., 1957.

The authors discuss the causes and functional and esthetic consequences of partial or total symblepharon and contracted sockets. They consider trauma and burns to be the most common etiologic factors but mention pemphigus and other cicatrizing diseases as occasional causes. They consider the pathologic anatomy of the lesions and discuss at some length the comparative value of grafts of mucous membrane from various areas and grafts of skin. They then outline surgical techniques and illustrate them well with drawings in black and white. They summarize their observations on 32 interventions in 31 patients and conclude that in general the results were satisfactory. Although some retractions took place, in no instance did they interfere with the wearing of a prosthesis.

P. Thygeson.

Valu, L. **Multiple lipoma of unusual form and topography in the orbital cavity.** Szemeszet **2**:81-83, 1958.

A case of a multiple orbital tumor with slow growth during 26 years is described. By orbitotomy five round tumors have been removed. Histologically the tumors proved to be mildly fibrotic lipomas.

Gyula Lugossy.

Vancea, M. P. and Vaighel, V. **Bilateral exophthalmos with papillary stasis from myositis and orbital cellulitis of undetermined cause.** Arch. d'opht. **17**:791-798, Dec., 1957.

The authors report a case of bilateral exophthalmos with papilledema following a myositis and orbital cellulitis in an individual 33 years of age. Biopsy examination revealed a nodular perivascular infiltration, edema, and diffuse hemorrhage, with modification in the muscle fibers. They conclude that the condition should be classed with the group of pseudotumors of the orbit. It was not possible to determine the etiology. Massive treatment with antibiotics had no effect on the evolution of the lesion.

P. Thygeson.

15

EYELIDS, LACRIMAL APPARATUS

Dencer, Derrick. **Use of polythene tubing in canthorhinostomy.** Brit. J. Plastic Surg. **9**:53-56, April, 1958.

The patient was injured in a road accident. Both canaliculi were divided by an extensive laceration. A canthorhinostomy performed by the author failed because of stenosis which regular dilation would not improve. The patient wore an acrylic tube dilator, but when it was removed the scarring again caused contrac-

tion. Secondly a small sector of the nasal bone was removed and large flaps of nasal mucosa were raised at the time of surgery and connected to the remnants of the lacrymal sac. Fluid in the lower fornix could be easily expressed into the nose, but again the sequence of events was repeated and the obstructive epiphora became complete soon after the operation.

A permanent indwelling polythene tube, with an outside diameter of 3 mm. was used to establish an artificial canthorhinostomy. The tube lay superiorly over the caruncle, having several fenestrations to drain the lower fornix, and then passed downward through an artificial ostium created in the right nasal bone and presented inferiorly in the nasal cavity below the middle turbinate.

This case is reported 15 months after the tube had been in situ. There were no complications. Alston Callahan.

Németh, L. **Some data on the surgical treatment of paralytic ectropion.** Szemeszet **95**:8-11, 1958.

Surgical treatment of chronic paralytic ectropion is dealt with. Because of functional results and its cosmetic effect the following method is recommended by the author. Starting from Imre's "skin strip incision" at the inner canthus, the fibers of the orbicularis oculi muscle are exposed. A muscle strip 3 to 4 mm. wide is isolated, a duplication is formed from the muscle strip and fixed by sutures to the internal tarsal ligament. Hereupon the skin strip is displaced upwards and fixed to the internal tarsal ligament. By this operative method excellent results have been obtained. Gyula Lugossy.

Orbán, T. and Eróss, S. **Developmental anomaly of the eyelid complicated by tumor formation.** Szemeszet **2**:76-80, 1958.

A case of meloschisis is described, associated with harelip and palpebral colloboma, and a verrucous growth on the eyelid, which later underwent a malignant degeneration. An epithelioma developed at the terminal end of the meloschisis, i.e. over the external corner of the eye too.

Gyula Lugossy.

Postic, S. **Observations on lacrimal trachoma. A comparative study.** Arch. d'opht. **17**:749-768, Dec., 1957.

Postic has made a comparative study of dacryocanaliculitis and dacryocystitis in trachomatous and nontrachomatous subjects. In canaliculitis due to streptothrix he found a dense subepithelial infiltration without follicles in which lymphocytes predominated. In canaliculitis produced by bacteria the infiltration was similar but less dense. In contrast he found plasmocytes to be predominant in the infiltration in trachomatous canaliculitis. He reports a unique case of streptothrix canaliculitis in an individual with cicatricial trachoma. He concludes that generally speaking the histologic differences between the two types of canaliculitis are not marked.

In chronic dacryocystitis in nontrachomatous individuals, lymphoid follicles are regularly found and differ very little from those found in trachomatous subjects. Even follicles rupturing into the lumen of the sac are seen in nonspecific dacryocystitis. The principal difference seems to be that plasma cells are much more abundant in trachomatous sacs. Only rarely are cicatrices and hyaline degeneration seen in trachoma cases; when they are seen they suggest the action of trachoma virus. The author states that many instances of canaliculitis and dacryocystitis in trachoma cases are not due to trachoma virus. P. Thygeson.

Serpell, G. **Xanthomata of the eyelids.** Tr. Ophth. Soc. Australia **17**:143-147, 1957.

The background of 26 patients with

xanthoma of the eyelids was investigated for arteriosclerosis (cerebral and general), hypertension, diabetes mellitus, coronary sclerosis, cholelithiasis, and obesity; 18 had one or more of the specified diseases.

Ronald Lowe.

16

TUMORS

Fry, W. E. and McDonald, P. R. **Malignant melanoma in the temporal periphery associated with macular symptoms as an initial finding.** Tr. Am. Acad. Ophth. **61**:397-403, May-June, 1957.

This is a report of two patients in whom the sequence of events was of particular interest: an initial complaint of disturbance of central vision, macular edema, and early macular changes, detected by scotometry. (6 figures)

Theodore M. Shapira.

Joyce, A. **Retinoblastoma in an adult.** Tr. Ophth. Soc. Australia **17**:67-74, 1957.

A review is given of previously reported retinoblastomas in adults. The present patient was 19 years of age and had three tumors in his right eye; the left eye had been removed for glioma of the retina when he was two years old. His father, a sister, and a brother had retinoblastomas. The three tumors were treated with radon seeds by a technique described in detail. Ronald Lowe.

Rouher, F. **Is the biopsy of the infantile orbital reticulosarcoma indicated?** Bull. et mém. Soc. franç. d'opht. **70**:423-435, 1957.

The reticulosarcoma of the orbit represents a clinical entity described as such by Offret in his report on orbital tumors. The tumors included in this group derive from the reticuloendothelial system. They are confined to the orbit, at least for a certain time. They are radiosensitive, but nevertheless very malignant, especially in children. Histopathologically the undifferentiated reticulosarcoma afflicts children only. The lymphosarcoma has been seen in children and adults, while plasmocytomas, myelomas and angioreticulocytomas only rarely occur in children. The clinical picture is characteristic. A unilateral exophthalmos develops rapidly in a child who is otherwise in good health. The malignant growth infiltrates the orbit diffusely so that no distinct tumor can be felt on palpation. Pseudoinflammatory signs like echymoses, swelling of the lids, and chemosis become visible. The pronounced protrusion does not yield to pressure; X-ray studies of the orbit are negative. Chemotherapy is of no benefit. The prognosis is considered to be very poor. The effects of surgery on the course of the disease was analyzed in 31 cases selected from the literature and the advantages of conservative treatment are evaluated. The clinical signs and symptoms are regarded as so typical that biopsy should be omitted and adequate X-ray treatment applied and repeated even in the presence of recurrences. The case histories of three children are discussed. These patients were successfully treated with X rays only. The survival time was eight, six and three years. (1 table) Alice R. Deutsch.

17

INJURIES

Garzino, Alessandro. **Detachment of the pigment layers and atrophy of the iris from contusion of the globe.** Rassegna ital. d'ottal. **27**:32-38, Jan.-Feb., 1958.

The eye of a four-year-old boy was struck by a blunt foreign body resulting in a dilated pupil, clouding of the media and a large plaque of brown pigment which was detached from the posterior surface of the iris and attached to the anterior surface of the lens. Vision was reduced to hand movements. A second

injury was sustained when the eye was struck by a horseshoe. Now the iris was found to be inverted and except for a small sector no trace of it was visible. Four holes were observed in the pigmented leaf. The zonular fibers were covered with pigment. (2 figures, 25 references) E. M. Blake.

Santoni, A. **The consequences of retention of intraocular splinters of glass.** Boll. d'ocul. **37**:81-88, Feb., 1958.

Santoni reports his experience with two eyes which had been injured by penetration of a splinter of glass. In one patient a splinter lodged near the optic disc and was retained for 11 years. In the other patient a splinter in the anterior segment of the globe had escaped notice for three years, when slight trauma led to hemorrhage, periodic inflammation and finally opacities in the deeper strata of the cornea and bulbous keratitis. After removal of the splinter these disturbances disappeared. (1 figures, 12 references) F. H. Haessler.

18

SYSTEMIC DISEASE AND PARASITES

Baron, André. **Four cases of temporal arteritis (anatomical and pathological studies by Kerneis, Hervouet, Lenoir).** Bull. mém. Soc. franç. d'opht. **70**:388-404, 1957.

Temporal arteritis represents the local manifestation of a generalized disease of the vascular system. Pathologically it is characterized by a granulomatous endarteritis, by invasion of the media with histiocytes and giant cells and by a fibromatosis of the adventitia with strangulation of the nerves. It is this strangulation of the nerves which causes the severe local pain. As far as the pathogenesis is concerned the presence of an auto-immunization factor could cause the extended endothelial damage consisting in an initial nonspecific endothelial insult. This would explain simultaneous affections like glomerulonephritis, polyarteritis or rheumatoid arthritis, also the presence of an increased sedimentation rate, the deviations in the globulin-albumin ratio and the occasional astounding success of cortisone therapy. Ocular complications are frequent, of poor prognosis, and dependant on the inclusion of arterial branches in the inflammatory and degenerative process. The ophthalmologic picture frequently does not coincide with the severe functional disturbance. An ischemic optic neuritis is visible as the result of a sudden closure of the nutritive supply to the optic nerve. Four case histories including detailed biopsy reports, are discussed. An atypical streptococcus was isolated from one biopsy specimen (fragment of the temporal artery). Similar findings have been reported by other authors. In spite of the rareness of positive bacteriologic findings a re-evaluation of the pathogenesis of this disease seems to be indicated. (11 figures) Alice R. Deutsch.

Bruna, F. **A fatal case of Stevens-Johnson syndrome following therapy with phenylbutazone.** Boll. d'ocul. **37**:3-16, Jan., 1958

The author reports the occurrence of a fatal case of Stevens-Johnson syndrome in a woman, aged 41 years, who had been given phenylbutazone therapeutically. Bruna stresses the importance of toxic factors in the origin of the disturbance, in addition to the generally accepted infection. (2 figures, 23 references) F. H. Haessler.

Connell, J. **Thrombosis of the internal carotid artery.** Australian & New Zealand J. Surg. **28**:12-17, 1958.

The cause of repeated "small strokes" including transient blindness or homonymous hemianopia is frequently an

atheromatous plaque at the origin of the internal carotid artery. Illustrative cases, with angiograms, are presented and the successful operative technique is described. Ronald Lowe.

Ditzel, J., Sargeant, L. and Hadley, W. B. **The relationship of abnormal vascular responses to retinopathy and nephropathy in diabetes.** Arch. Int. Med. **101**:912-930, May, 1958.

A biomicroscopic study was made of the bulbar conjunctival vascular patterns in 60 young diabetics who had both retinopathy and nephropathy. In 83 percent of these, abnormal conjunctival vascular patterns were found as compared with 51 percent of a group of juvenile diabetics without vascular disease and one percent of a group of nondiabetic controls. The degree of the conjunctival vascular changes were correlated with the severity of retinopathy and nephropathy, irrespective of the duration of the diabetes. Since these abnormal conjunctival patterns are reversible it is felt that the changes are not caused by vascular degeneration, but are due to abnormal vasomotor response. It is postulated that similar abnormal vasomotor changes occur in the small vessels of the retina and that they are a precursor of diabetic retinopathy. (9 figures, 6 tables, 10 references) William S. Hagler.

Draganesco, S., Lasco, F., Nicolesco, M. and Chivu, V. **Uncommon manifestations of the meningo-uveal syndrome.** Ann. d'ocul. **191**:293-296, April, 1958.

The authors report three cases of meningo-uveal syndrome in which the initial symptoms were those of increased intracranial pressure: papilledema, convulsions and confusion. However, ventriculography was negative and the spinal fluid findings were those of an inflammation of the meninges. In several days all three patients showed evidence of uveitis and finally a diagnosis of Harada's disease was made in one case and of Vogt-Koyanagi syndrome in the other two. Response to therapy was poor in two cases. The third patient showed a response to aureomycin and cortisone. (3 references) David Shoch.

Ewing, M. **Ophthalmological salivary syndromes.** Tr. Ophth. Soc. Australia **17**:75-81, 1957.

The author reviews the historical development of nomenclature concerning parotid gland syndromes. Some disease entities have been clearly defined but there is still much uncertainty with others. The concept of auto-antibodies is stimulating and revolutionary.

Ronald Lowe.

Guadalupi, U. and Pampiglione, S. **Posterior internal ocular myiasis.** Boll. d'ocul. **37**:17-31, Jan., 1958.

The larva of Hypoderma bovis in its first stage was noted in the ciliary body of a seven-year-old boy from Sardinia. This is the first case to be described in Italy. The authors record clinical histopathologic and parasitologic findings. The life cycle of Hypoderma is reviewed. (6 figures, 31 references). F. H. Haessler.

Hogan, Michael J. **Ocular toxoplasmosis.** Tr. Am. Acad. Ophth. **62**:7-37, Jan.-Feb., 1958.

The present knowledge of toxoplasmosis in ophthalmology is completely reviewed. Historically, the organism was discovered by Nicolle and Manceaux in animals in 1908; it was reported in man by Wolf and his associates in 1938; and for its recognition the toxoplasmin skin test was reported in 1947, and the methylene blue dye test in 1948. Feldman and Sabin demonstrated serologically the widespread incidence of the disease, both

geographically and zoologically. It is a protozoan parasite, four by seven microns, crescentic in its extracellular form, and round intracellularly. Widely pathogenic, it is easily transmitted by any route, gives rise to antibody formation and prefers the CNS where it can survive for years.

Frenkel and Siim have classified toxoplasmosis as congenital (apparent or inapparent) and acquired (exanthematous, meningoencephalitic, lymphadenopathic, and ocular). The congenital type is determined by the virulence of the organism, fetal or maternal resistance, and the stage of pregnancy at which infection takes place. Early infection means fetal death, mid-pregnancy produces severe manifestations such as hydrocephalus or microphthalmos if the fetus survives, and late infections produce acute manifestations such as encephalomyelitis, chorioretinitis and visceral lesions.

Acute chorioretinitis may be present at or shortly after birth and is associated with acute systemic disease; or, developing after birth, it is not always associated with acute systemic infection. It is one of the most constant lesions in congenital toxoplasmosis. This type causes loss of vision since the disc and peripapillary areas are frequently involved. Its appearance may be delayed, suggesting intermittent parasitemia. The retina is primarily involved, with copious exudation into the vitreous. The foci are large, usually with smaller satellites. The choroid is secondarily involved, and marked elevation can occur. Organisms can be found free or encysted in the lesions. Pseudocysts are parasitized cells, and may reactivate the disease on rupturing. Dye test antibodies develop within three to four weeks of onset and rapidly reach high titers. Complement fixation antibodies do not develop for five to six weeks. Both reactions persist about five years, then gradually decrease, consequently any dye test titer in a child below 10 years of age should be considered significant.

Subacute chorioretinitis occurs with little or no evidence of systemic disease. Here there may be healed or active lesions; however, serologic reactions confirm the diagnosis here as elsewhere.

In Hogan's own series, 36 cases of congenital toxoplasmosis were found in over 1,500 patients with endogenous uveitis. Nine of these had negative skin tests, yet showed positive dye tests. The commonest presenting complaint was strabismus, being present in 20 of the 36 cases. Positive skull films were found in only seven children. Multiple and bilateral lesions were common. The entity of late relapse was found in four cases, and detailed case reports are given. These should not be confused with acquired cases, nor with the Sabin-Feldman syndrome due to cytomegalic inclusion virus.

Acquired toxoplasmosis has four forms as enumerated above. In the exanthematous form, which resembles rickettsial disease, no eye lesions have been reported. The meningoencephalitic form appears to be very rare. The lymphadenitic form is quite frequent and may be febrile, afebrile, or subclinical. The ocular form of aquired toxoplasmosis is not as common a cause of chorioretinitis as is the congenital, and diagnosis of the former should be made with considerable conservatism.

In over 1,000 cases of uveitis, 44 percent had positive sera (titer of 1:16 or higher), the incidence of such "positive" titers being 25 percent of the "normal" population. Detailed case histories of five informative cases of acquired toxoplasmosis are presented, two of them associated with systemic findings.

Daraprim-sulfadiazine therapy, so much in vogue, proved to be disappointing, giving good results in only 25 percent of cases; however, the addition of prednisone or prednisolone seems to have improved

the results. (27 figures, 7 tables, 44 references) Harry Horwich.

Mavioglu, Hilmi, **Fiessinger-Leroy-Reiter's syndrome.** Missouri Med. **55**:228-240, March, 1958.

In this most comprehensive review the author shows that the "Syndrome-Conjunctivo-Uretero-Synovial" was presented by Fiessinger and Leroy in France, six days before Reiter's paper was published in Germany. The syndrome is a clinical entity. The etiologic agent is probably a virus and the portal of entry, the urogenital tract. The triad in order of severity is arthritis, nonspecific urethritis, and eye involvement. The syndrome usually starts with urethritis, followed by conjunctivitis, and then, arthritis. Remissions are characteristic. Prognosis for life is good. It usually occurs in young males. Treatment is supportive. Behçet's recurrent disease should be excluded if the patient is female, or if the posterior half of the eye is involved. (2 figures, 2 tables, 87 references) Irwin E. Gaynon.

Mueller, H. K. **The importance of ophthalmodynamometry in internal medicine.** Arch. chil. de oftal. **39**:92-97, July-Dec., 1957.

The author describes the ophthalmodynamometric findings in cases of hypertension, where, he feels, a strong relationship exists between the pressure in the central artery and the humeral pressure. Vasomotor headaches can be studied in detail by means of this diagnostic method. (3 graphs) Walter Mayer.

Ram, D. and Rohatgi, J. N. **Laurence-Moon-Biedl syndrome.** Brit. J. Ophth. **42**:372-375, June, 1958.

A single patient presenting all the manifestations usually found in the Laurence-Moon-Biedl syndrome, a 10-year-old white male, is described. It is rather rare to find obesity, hypogenitalism, polydactyly, mental retardation, and the findings associated with retinitis pigmentosa, all in one patient. All siblings were normal except one younger brother who had polydactyly. Etiologic factors are discussed but nothing of note could be ascertained in this family. (29 references) Lawrence L. Garner.

19

CONGENITAL DEFORMITIES, HEREDITY

Billings, J. J. and O'Day, K. **Refsum's syndrome: heredopathia atactica polyneuritiformis.** Tr. Ophth. Soc. Australia **17**:131-136, 1957.

The patient presented the features described by Refsum: atypical retinitis pigmentosa, nerve deafness, icthyotic skin, congenital deformities of the hands and feet, polyneuritis, cerebellar ataxia, raised protein level in the cerebrospinal fluid with albumino-cytologic dissociation, and death from cardiac failure.

Ronald Lowe.

Cahill, J. B. **Pseudoxanthoma elasticum.** Australian J. Dermatol. **4**:28-32, 1957.

This paper summarizes the diverse features of the disease, then presents briefly a family tree including five cases in three generations. Ronald Lowe.

Glasgow, G. L. **A case of amaurotic family idiocy with lipid storage disease of bone.** Australasian Ann. Med. **6**:295-299, 1957.

The report describes a woman, aged 21 years, with characteristic retinal signs, evidence of widespread neurological disease with myoclonic jerking, and a family history of blindness and death in infancy. The patient was observant, had an accurate memory and an I.Q. of 95. Central scotomas and pendular nystagmus were present. Radiographs and marrow biopsies showed a lipid storage disease of the

bone marrow resembling Gaucher's disease. Ronald Lowe.

Graham, M. V. and Pitts Crick, R. **Bilateral congenital buphthalmos in two sisters.** Brit. J. Ophth. **42**:370-371, June, 1958.

Two cases of buphthalmos present at birth in sisters are described. No familial history of any pertinence was elicited and there is no parental consanguinity. Multiple surgical procedures in both brought about no promising results. (1 figure, 3 references) Lawrence L. Garner.

20

HYGIENE, SOCIOLOGY, EDUCATION, AND HISTORY

Evans, P. J. **The natural incidence of ocular disease.** Tr. Ophth. Soc. Australia **17**:27-37, 1957.

During the last 25 years most profound social, political and scientific changes have occurred. The author discusses the different patterns of ocular disease that have occurred during this period in the United Kingdom. The following factors are considered: climatic, nutritional, metabolic diseases, social changes, degenerations, occupational hazards, and therapeutics. In the discussion following the paper further information was given from Australia, Asia and America. Ronald Lowe.

Kuhn, H. S. **Industrial ophthalmology of 1957.** Tr. Ophth. Soc. Australia **17**:99-106, 1957.

The following subjects are discussed: first aid and emergency eye care (with standing orders for industrial nurses), chemical eye injuries (early irrigation, no neutralization), ultraviolet and infrared radiation (welders' flashes cannot cause intraocular damage), new areas of industrial endeavor (monocular aphakic corrections, industrial orthoptics), and professional participation inside the gates of industry (it is a duty of ophthalmologists to participate in plant activities).

Ronald Lowe.

Myers, R. H. **Present relationship between ophthalmology and optometry.** Rocky Mt. M. J. **55**:41-44, May, 1958.

The relationship between ophthalmology and optometry is discussed and the official stand of the House of Delegates of the American Medical Association is presented. Three of the four resolutions adopted by the House of Delegates in 1955 dealing with this subject are discussed. It is urged that all physicians be aware of the proposed legislation by optometric groups and alerted to the "dangers inherent in legislation that would limit, restrict, or even forbid to a physician the exercise of certain of his medical privileges." William S. Hagler.

Roberts, F. G. **The education of the legally blind child.** Tr. Ophth. Soc. Australia **17**:137-143, 1957.

The education of a blind child should be integrated with that of the normal children of his home and community.

Ronald Lowe.

NEWS ITEMS

Edited by Donald J. Lyle, M.D.
411 Oak Street, Cincinnati 19, Ohio

News items should reach the editor by the 10th of the month. For adequate publicity, notices of postgraduate courses and meetings should be received three months in advance.

Announcements

Southeastern research meeting

The Southeastern Section of the Association for Research in Ophthalmology will hold its initial meeting in Winston-Salem, North Carolina, on Friday and Saturday, December 5 and 6. Those interested in presenting papers should write the chairman for this meeting, Dr. Richard G. Weaver, Bowman Gray School of Medicine Winston-Salem, North Carolina.

Michigan postgraduate conference

The annual ophthalmology conference at the University of Michigan will be held April 20, 21, and 22, 1959, under the direction of Dr. F. Bruce Fralick, chairman of the Department of Ophthalmology. Applications may be addressed to the Department of Postgraduate Medicine, University Hospital, Ann Arbor, Michigan.

Glaucoma course

The Mount Sinai Hospital of New York together with Columbia University gave a course in "The diagnosis and management of glaucoma" from October 7th to October 23rd. Gonioscopy and tonography were stressed.

Ophthalmoscope course

The Mount Sinai Hospital of New York together with Columbia University is giving the following courses: "The use of the Schepens' ophthalmoscope" from March 10 to March 26, 1959. "Histopathology of the eye" from April 1 to April 24, 1959. Complete information can be obtained from the Registrar for Medical Instruction, The Mount Sinai Hospital, 1 East 100th Street, New York, New York.

Schoenberg lecture

The annual Schoenberg Memorial Lecture sponsored jointly by the New York Society for Clinical Ophthalmology and the National Society for the Prevention of Blindness will be given at 8:15 P.M. on Monday, December 1, at the New York Academy of Medicine, 2 East 103rd Street, New York.

Dr. Harold G. Scheie, professor of ophthalmology at the University of Pennsylvania, Philadelphia, will give an address on "Management of infantile glaucoma." This eye disease is an important cause of blindness among children because of its early effects on the retina and optic nerve, and Dr. Scheie has conducted research on its surgical treatment.

Mark J. Schoenberg, M.D., a New York ophthalmologist, was prominent in the work of both the National Society for the Prevention of Blindness and the New York Society for Clinical Ophthalmology. Since his death in 1945, the two societies have joined each year in honoring his memory. All physicians will be welcome.

Special lecture series

Under the auspices of the Institute of Ophthalmology of the Americas, Prof. Dr. G. Meyer-Schwickerath of Bonn, Germany, will give a series of lectures on "The new method of light coagulation in the treatment of fundal pathology," at the New York Eye and Ear Infirmary, on the following dates:

Wednesday, November 19, 1958, from 5:00-7:00 P.M.
Thursday, November 20, 1958, from 5:00-7:00 P.M.
Friday, November 21, 1958, from 10:00-12:00 NOON.

The registration will be limited. The fee is $30.00. For further information, please write: Mrs. Tamar Weber, Registrar, 212 Second Avenue, New York 3, New York.

Societies

Colorado Ophthalmological Society

The ophthalmologists of Colorado Springs were hosts to the Colorado Ophthalmological Society's meeting in their city on September 20th. Guest speaker was Dr. Dan M. Gordon of New York City. He spoke on "Corticosteroid therapy in uveitis," stressing the importance of steroid therapy being given soon enough, in large enough dosage, and over a long enough period of time.

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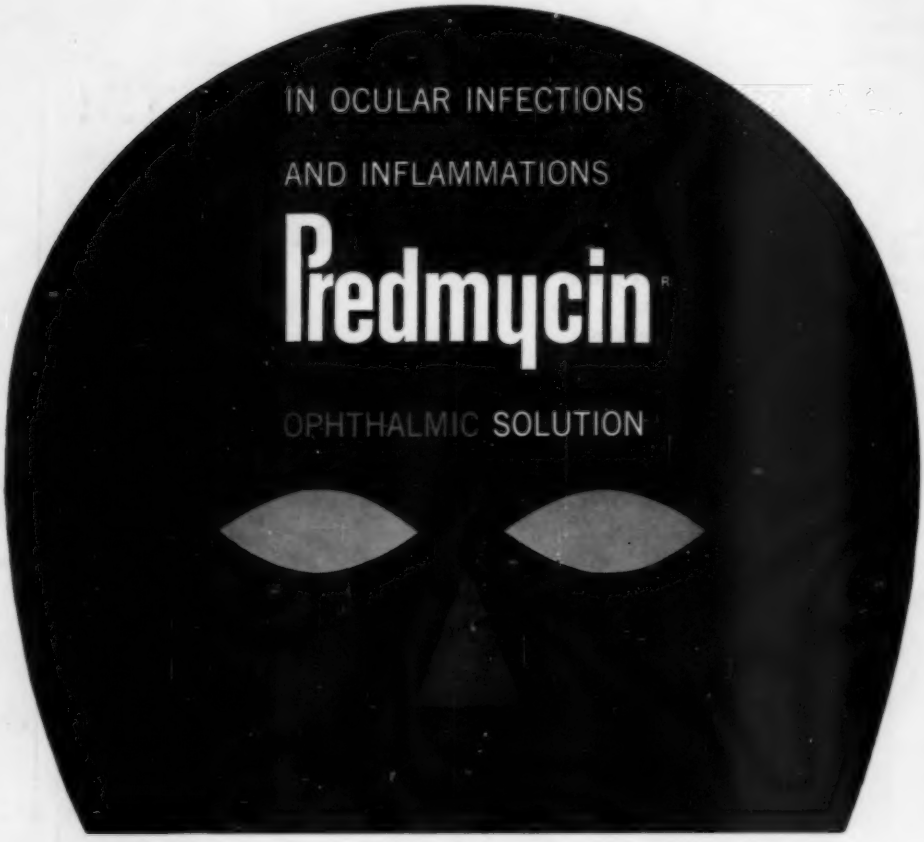

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THE END OF THIS VOL.